MACHINERY.

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DESIGN AND CONSTRUCTION OF METAL WORKING SHOPS*—1.

W. P. SARGENT.†

W. P. Sargent.‡

A PERIOD of general depression may not seem timely for projects involving the expenditure of large sums, but, obviously, thorough study and discussion of tentative plans can be the better made during dull times, as the efforts of all concerned are not directed towards the crowding of production.

The great advantages in having new shops ready, or, perhaps, one may better say, the disadvantages of insufficient space when a rush in business comes on, are well known. If the fact were better appreciated that a saving equal to thirty per cent of the amount expended may easily be made by building during a time of depression rather than during a period of inflation, many corporations would not, as may now be seen on every hand, have their new shops ready for occupancy at the *termination* rather than at the *beginning* of a prosperous period.

Irrespective, however, of the time when extensive improvements are to be made by a growing concern, the problems arising are involved and seemingly numberless. Few but they who have had to meet these problems can appreciate the paucity of general precedents that are available in the planning and carrying out of extensive improvements, especially under the severe condition that but slight interference with production is permissible.

Scope of Articles.

From the premise that the desired benefits from extensions must be secured at a reasonably low cost, as quickly as the need demands and conditions permit, and without restricting production, the author proposes to discuss in the following articles the subject of industrial plant extension as applied to metal working industries, from the time when extensions are tentatively considered to the time of occupancy. Data will be given enabling the plant engineer to proceed steadily and rapidly, and also giving his employers information by which his efforts may be intelligently checked. Presumably many of the propositions advanced will meet with a variance of ideas, but wherever positive positions are taken, the author will endeavor to give sufficient reasons therefor.

Main Periods of Construction.

The time necessary for the planning of an extensive series of improvements, and for the execution of these plans, may be divided into four main periods which will be styled, the inceptive, the formative, the progressive, and the conclusive period, respectively.

The Inceptive Period.—The inceptive period covers the time of compiling the necessary data and the study of the best examples of recently constructed plants. This study will reveal to the mind the comparative advantages of different arrangements and of various types of buildings. During this period one's mind will be forming various schemes, even though sub-consciously.

The Formative Period.—During this, the mental structures assume more and more tangible and definite forms as the tentative planning, revising, the definite planning, and the securing of prices are taken up.

The Progressive Period.—During this period the contracting, constructing, and moving are carried on.

The Conclusive Period.—When the new shops are partly operative, the inevitable gaps in the general scheme are filled, and summations and comparisons of costs are made.

The chart, Fig. 1, is prepared to show more clearly the relation of the various periods and sub-periods, and also to show approximately the duration of the periods, assuming that a total of twenty months should cover the work from the commencement of the tentative planning to the completion of the work. Before going into the detailed discussion however, the author will advance the following general propositions.

General Considerations.

Engineering the construction of a series of extensive industrial improvements is decidedly a one-man job as regards control. This statement holds good whether the engineering is done by one of the many firms or individuals making a specialty of industrial plants, or by a temporary organization drawn from the staff of the owners themselves. The engineer who is to successfully carry through to completion a large project of this kind should be a high-class man, and, consequently, well paid. Generally, an engineer from outside is to be recommended, as his work will meet with less obstruction. "A prophet is never without honor save in his own country" is peculiarly applicable to this class of engineering. One can be too conciliatory in trying to prevent friction. This idea of the author's results from a recent experience with the vacillating nature of a few individuals backed by a general, narrow, insular indisposition to move from the beaten track and to accept the benefits of more efficient facilities of proven merit.

The duties of the engineer-in-charge carry a great responsibility and demand a rare combination of abilities. Given that the engineer is to have undisputed charge of the work (of course, subject to his employers' approval), and is to be the sole intermediary between his principals and the contractors, he should possess to a high degree honesty, discretion, tact, and the ability to observe closely, to analyze well, and to think honestly and methodically. He should possess executive and originative capabilities, combined with good common sense. He should have the temperament and stamina to withstand intensive and tenacious application. He must not be afraid to say "I do not know," but he should know the next time, would he secure and retain the respect and confidence of his associates and subordinates.

The efficiency of an industrial plant is *not primarily dependent upon the buildings*, but is mainly dependent upon the personnel, the equipment, the facilities for handling the materials and the product, and the arrangement of space. The buildings proper only affect the efficiency inasmuch as they do or do not provide good light, good air, sufficient headroom, and a reasonable degree of comfort for the workmen. Therefore, the nature of the covering for the space is secondary, and is determinable by the three main considerations of utility, cost, and reasonable architectural effect. No one type of buildings, whether mill construction, iron covered, brick and steel, or reinforced concrete will meet all condi-

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tions. We will later take up the comparison of various types of buildings, and the conditions for which each is best adapted.

Successful large plants are not of mushroom growth, but have grown building by building from a single small shop. Seldom have additions been made with any thought aside from that of providing for the existing need. Consequently, many large plants are a compact, irregular collection of buildings, sometimes separated by streets, tracks or water courses. However, the floor space occupied by various branches of work, and the number of men and power consumption for various units of space, form the logical working basis either for designing a new plant on ample ground space, or for alteration and the providing of additional facilities on whatever ground is available contiguous to existing buildings. Of course, the *space per man* in some of the departments may be too little for efficient production, and care should be taken to make allowance for this factor.

The labor supply may weigh heavier than all other factors in determining the justifiable limits of extension. In one instance of a city of 30,000 inhabitants, metal working industries have enlarged in recent years to the extent that an employer of 1,100 men stated his belief that 1,500 men

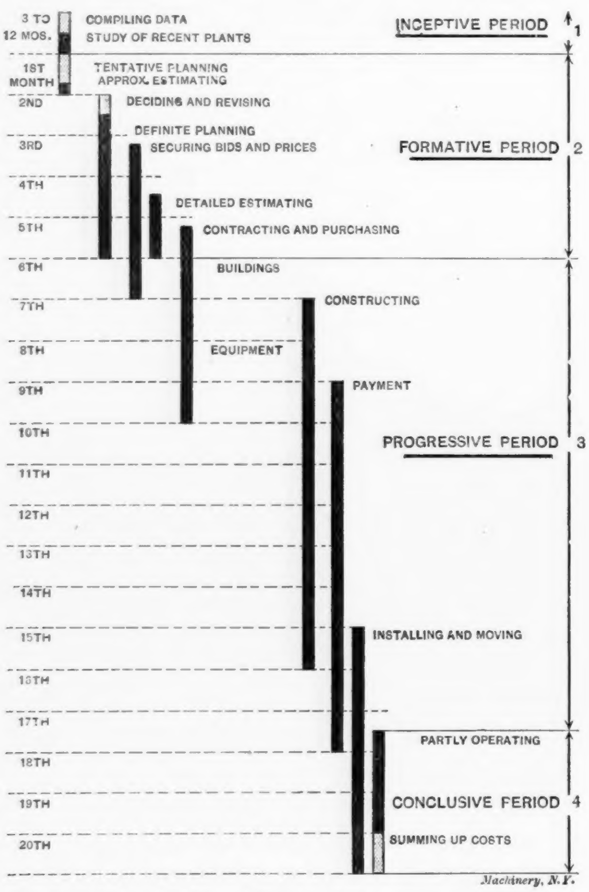


Fig. 1. Relation of Different Stages of Shop Construction Work.

would be the maximum he could gather in his shops in years to come without resorting to colonization. This belief came from the knowledge of the fluctuating demand for the product, the few apprentices taken on from year to year, and the scarcity of houses rentable at a low figure. The doubling in size of this plant would be a precarious proposition compared with the same increase in Philadelphia, for instance, where the general manager of a large metal working firm stated that he had increased his force 18 per cent in two months, or in Milwaukee, where one concern increased its force 1,200 men in eight months. Both above instances were with business at its best.

The sectional bookcase idea as applied to the laying out of new plants meets all the requirements of departmental balance and of future extension, the various departments corresponding to the sections, and a group of departments making up a unit. The West Allis Plant, of the Allis-Chalmers Co. in Milwaukee, exemplifies this idea. The first buildings were designed for large engine work, while the recent additions were designed for both large and small work of an entirely different nature. The new buildings were slightly modified in type, yet they merge into the general scheme as naturally as rain into a river. Of course, old plants can not be changed to conform with this ideal; still, much can be done to give the product an economical routine through the works, and to arrange the departments so that future extensions could be made in conformity with a predetermined plan. Time may be profitably devoted to the critical study of recent plants. First study the main features of large plants from articles in various technical papers; these articles are generally written by men having a thorough understanding of the fundamental reasons for existing conditions. Generally, in visiting, one can only glance over the thousand and one features, and the information obtained is merely confirmative or disputative of predetermined conclusions.

Tentative plans should be comprehensive and flexible. Several solutions should develop from a thorough study of the problem, but each one of these various plans should be complete, comprising every item of work, and each item with an approximate estimate of cost. Approximate estimates based on square foot and cubic foot figures for cost of buildings, added to estimates on every item that can be thought of, will be, in total, close to actual costs even though some particular items may be within broad limits. The estimate of the total cost of a given project should never be decreased merely because some items may be excessive, for the reason that subsequent changes are more apt to increase the cost rather than to decrease it. The engineer will make a great mistake if, when the plans are decided upon and revised, he assents to the cutting of an estimate piece-meal, coupled with the expectation that the same definite quality and quantity of work is to be done. The "powers that be," in considering the tentative plans, will look at them from a business, rather than from an engineering, standpoint, and all statements must be well substantiated in order to secure an appropriation equal to the estimate. It is probable that from the several tentative schemes a definite general plan can be worked out, meeting all requirements and carrying the approval of the owners of the plant.

After the general plan is decided upon, the definite instructions and detailing should be rushed hard if the extensions are needed quickly, as it is economy to spend a couple of thousand dollars (on a large proposition) in correcting minor errors, if, by so doing, the plant may be in operation a month or two sooner. This latter statement should not be construed as advocating careless design, but the author does not believe in spending an excessive amount of valuable time altering and checking drawings where the monetary factor is small.

After a resumé of the items of data required and their bearing on various problems, an epitome of the leading features of recent plants will be given. The planning and construction of a large plant will then be taken up in detail.

Data Required for Planning Shops.

The following items of data have been found either a necessity or a convenience in planning alterations and in laying out new plants. In the first place, an engineer's plat of all the space within the property bounds is required. This plat should preferably be made by the city engineer's staff, or by a firm of civil engineers which can be held responsible for the accuracy of the work done, and which also is in touch with the city engineer's records and can derive exact information from deeds and records. The scale of the plat should be 1/32 inch to a foot, or some multiple of 1/32 inch. Many civil engineers will object to this requirement, as it necessitates a departure from their usual units of measurement, but their unit of a tenth of a foot is not adapted for construction work. If the total space cannot be covered by one sheet, approximately 36 x 48 inches, the plat should be made in sections. If made in sections, a street line or a witness line, not cutting any buildings, should be made the division line between the sections. For desk use, a photograph of the entire plat should be made, as it enables one to have all leading features and dimensions of a piece of property in a very convenient form for study.

The plat should show: 1. The owner's property limits. 2. The adjacent property limits and owners. 3. The block outlines of all buildings, and dimensions of the buildings outside of pilasters. 4. Accurate tape measurements between the various buildings and at all critical points. 5. Leading dimensions should all be referred to two base lines at right angles, one of these base lines paralleling the general trend of buildings. 6. Tracks should be shown with dimensions to nearest rail. 7. All municipal underground work in streets, such as sewers, water-pipes, gas-pipes, conduits, manholes, etc., should be shown in location, and their depths below the surface noted. 8. Grades or levels of floors, tracks, pits, streets, surfaces and beds of streams or ponds should be indicated. In a word, this plat should be sufficiently accurate to allow of larger scale drawings being made from it without prohibitive errors. Obviously, this plat is of most value in planning additions, as extensions can then be made without fear of encroaching on adjoining property; still it furnishes an accurate basis for comparison when designing a new plant.

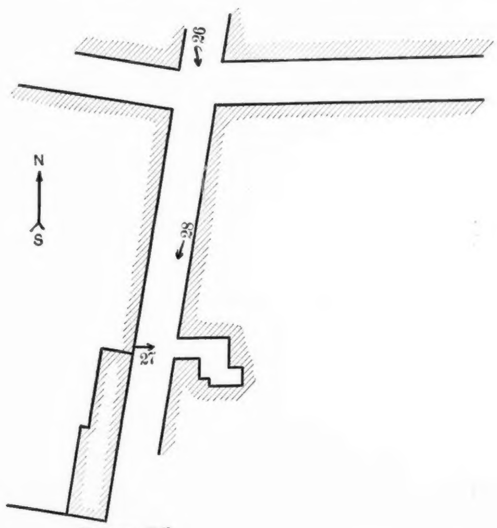


Fig. 2. Method of Recording Photographs on Plat.

A tracing should be made from this plat, and all underground pipes, sewers and also trackage on the owner's property should be added to the municipal underground work already laid out. Depths and location of these pipes can be obtained first from such drawings as may be available, and second by checking these drawings by boring with a 2-inch auger having an adjustable handle.

Space Data Required.

In making up details of space used for various purposes, it is better to have areas inclusive of walls, partitions and pilasters, so that the details may be totaled and checked against the gross area as obtained from the engineer's plat. The various divisions and sub-divisions of space required for the determination of the total occupied space for the extensions are indicated in the following lists. The number of square feet of floor space, and the number of men for each division must be ascertained, and from these figures may be obtained the number of square feet per man and the percentages of area of divisions compared with the space taken for machining.

Machine Shop. — Machining — Assembling — Tool-making —Tool storage—Shop stores—Work in progress—Storage—Washrooms—Closets—Shop offices.

Finished Work Storage.

Shipping.

Smith Shop.—Steam hammers—Forges and anvils—Bulldozers and furnaces—Case-hardening—Iron storage inside—Iron storage outside—Coal storage—Washrooms—Offices.

Foundry.—Molding under 20-ton or larger cranes; under 10-ton cranes; under 5- and 3-ton cranes; under 1-ton cranes—Bench molding — Machine molding — Core-making — Large cores made under cranes or baked on trucks—Small cores baked in portable ovens—Cleaning, under 20-ton cranes; under small cranes—Pickling tanks—Sand blast—Charging floors—Cupola floors—Sand mixing—Sand storage—Coke storage — Supply storage — Washrooms — Closets — Foundry office—Flask storage—Pig-iron storage—Casting storage.

Brass Foundry.—Molding—Core-making—Furnaces—Cleaning—Flask storage—Supplies.

Steel Foundry. — Molding — Core-making — Converters — Cupola room—Charging floor—Annealing—Cleaning — Supplies.

Pattern Making.—Pattern lumber storage—Dry kiln.

Carpenter Shop.—Lumber storage.

Power Plant.—Boiler room—Engine room—Pump room—Pipe shop—Electrical stores—Coal storage.

Main Office Building.—Offices—Drawing-rooms—Vaults.

Total Floor Space.—Ground floor—Galleries.

Total Yard Space.

Total Ground Space.

Heights and spans of crane tracks affect somewhat the arrangement of space, but this will be considered later.

Methods of Keeping Data.

In order to have the data of existing plants in shape for pocket or desk use, the following sizes of sheets will be found convenient. For tabulated and other data for pocket use, Morden's loose-leaf book No. 6—pages 4 x 7½ inches—is suitable. Write with fountain pen ink on one side of the sheet. Many engineers of the author's acquaintance use books of this size, and, as the pages blue-print nicely, there is a possibility of an interchange library of data.

For desk use only, employ a loose leaf book 9 x 12 inches. This size enables one to bring together drawings 9 x 12 inches, photographs 8 x 10 inches mounted on muslin, and typewritten correspondence on standard 8½ x 11-inch letter sheets.

For drawings, sizes in multiples of 9 x 12 inches are used, as most reference drawings of details are of sufficiently large scale when drawn on 12 x 18-inch sheets, and this size sheet can be placed in a desk drawer.

For indexing photographs, use the extremely simple method of placing an arrow on an 8 x 10-inch photograph of the engineer's plat, indicating the position and direction of camera when the photographs were taken, and put the distinguishing number of the negative close by the arrow. See Figs. 2 and 3.

Fig. 3. Photograph Marked to correspond with Number on Plat.

Photograph Data Required.

The photographs required are: photograph of engineer's plat, interiors and exteriors of buildings, yard space, vacant space, trackage, prospective sites, and photographs taken during construction. These latter are invaluable in many respects. Without leaving his desk, the engineer can study and plan unhampered by the numerous questions asked in the field whenever he is in sight. The photographs will often give bits of information, or verify some little point that it would take a fifteen minutes walk to investigate on the ground. An engineering salesman can often be given a general idea of what is wanted before he is taken on the ground, making his mental impression doubly strong, and therefore securing his attention on even small matters. Photographs are also incontrovertible evidence, many times, when differences arise and claims are made by contractors.

Drawings of Existing Plant.

Drawings of existing plant should preferably be made on sheets 12 x 18 inches. Simple elevations and sections of various buildings, showing door, window, and skylight spaces, crane tracks and galleries, together with plans supplemented by photographs of interior views showing walls, columns, partitions, etc., furnish a reference basis for problems of lighting, heating and headroom. Plans of wiring for cranes, power and lighting, and piping for steam, water, gas, and air, furnish data for definite conditions that hand-books could not begin to supply. Plans of shafting giving sizes, length of sections, location of hangers, used and unused sections, etc., will save their cost many times over.

Production Data.

The production of various departments per unit of space, per man, and in total, will often times show where departments are lame and what variations are necessary in establishing unit space figures. The nature and value of the various classes of product in relation to the space occupied should be considered, as the project of extension may be expected to increase the production of various classes of machines by different percentages. For instance, a plant building a varied line of tools will want to perfect and increase the production of the class for which there is the greatest demand, and in which there is the greatest profit. Production data are, naturally, confidential, and should not be kept with other data that may be accessible to the construction engineer's assistants. The average number of labor hours of each class of workmen per machine, the number of hours worked per day, the number of square feet of floor space per man, and the number of machines to be built, will afford data for the planning of improvements, if the problem is stated from a production basis rather than as a percentage increase of men and space. Dimensions and weights of the largest and heaviest pieces produced help to determine the capacity and headroom necessary. Maximum heights and widths of loaded flat cars that will be accepted by the railroads will give the minimum height of lintels of doorways through which the largest pieces are shipped.

TABLE I. SPACE. PLANT NO. 3, ALLIS-CHALMERS CO.
Data from old shops.

Department.	Floor Space, square feet.	No of Men.	Sq. Feet per Man.	Ratio.
Machine Shop	276,484	966	331	100
Erecting Shop	43,425			15.8
Shipping	......	...	...	.....
Foundry	142,984	607	235	52
Sand Floor	......	..	...	.....
Pattern Shop	28,643	80	358	10.4
Smith Shop	11,830	65	182	4.4
Manufacturing Space	503,366	1718	Average 293	.....
Pattern Store	82,870	....	...	29.7
Engine Room	......	....	...	.....
Boiler Room	......	....	...	.....
Office Building	40,170	175	230	14.6
	626,406	1893	Average 330	.....

TABLE II. SPACE. ONE COMPLETE UNIT FOR 555 MEN.

One-unit.	Space, square feet.	No. of Men.	Square Feet per Man.
Machine Shop / Erecting	116,000	351	331
Foundry	41,000	175	235
Pattern Shop.	10,400	29	358
	167,400	555	Average 302

Expense Data.

The costs of handling materials, and other expense items, should be carefully collected, as successful overgrown plants generally are carrying an overhead expense that can be materially reduced when the business is established in a new plant. This reduction of overhead expense is often the principal factor in increasing the productive efficiency of a new plant, as the production per producer is high, correlative to the fact that the overgrown plant has been, generally, successful.

The problems in reducing expenses are generally of two classes, first, to lessen manual labor, and, second, to increase the efficiency of apparatus used in work chargeable to expense accounts. The importance of knowing these costs is shown by the following data from a plant employing 1,000 men: The cost of handling pig iron per ton is 23 cents; coke, 42 cents; sand, 40 cents; coal, 10 cents; and bar steel and billets, 90 cents. The total for these five items per year amounts to over $7,000, and a saving of 50 per cent can be made by installing efficient apparatus in a new plant. As many conservative managers believe that a saving of laborer's wages of $600 per year justifies the expenditure of $5,000, this saving of 50 per cent on $7,000 alone would justify an expenditure of $30,000. The heating of this same plant costs $6,000 per year, and a saving of $4,000 per year can be effected in a new plant with proper apparatus.

TABLE III. SPACE. PLANT NO. 6, ALLIS-CHALMERS CO.
Data from new shops as built.

Department.	Floor Space, square feet.	Ratio.	Block Space, Dimensions.
Machine Shop	189,750	100	two {575 × 118, 575 × 47} each
Erecting Shop	40,752	21.5	566 × 72
Shipping	21,508	11.5	566 × 38
Foundry	123,388	65	566 × 218
Sand Floor	8,490	4.5	283 × 30
Pattern Shop	31,000	16.5	566 × 55
Smith Shop	50,150	26.5	425 × 118
Manufacturing Space	465,038	....	....
Pattern Store	144,900	76.5	566 × 64
Engine Room	8,850	4.6	75 × 118
Boiler Room	8,850	4.6	75 × 118
Office Building	....	....	....
	627,638	....	....

TABLE IV. UNITS REQUIRED FOR NEW SHOP.

Department.		Square Feet.
Machine Shop / Erecting Shop	two units	230,500
Foundry	three units	123,390
Pattern Shop.	three units	31,000

Power Data.

The cost of coal, supplies, water, and attendance, also the capacity and efficiency of engines, generators, boilers, condensers, transmission lines, shafting, belting, etc., should be found, and costs of power obtained under the varying conditions of day and night operation, busy times and bad times. This information will aid in settling the question of increasing or changing the power plant.

Construction Data.

Local prices of materials entering into construction, and cost of labor in the building trades, should be obtained early, as it will take some time to check and verify them sufficiently for use in close estimating. The various items of material that will be used in large quantities are as follows:

Foundation Work.—Cement; crushed rock; sand; reinforcement steel bars; expanded metal; water-proofing compounds, such as "Medusa"; lumber for form work.

Framework.—Structural steel work erected per ton; trusses; girders; columns; bracing; floor plate.

Walls.—Plain brick; face brick; bull nose brick; cut stone sills; tile coping; window frames, single, double, and triple; windows per square foot.

Roofing.—Purlins; sheathing; gravel or slag roofing; skylights per square foot; tin and copper flashing per square foot; galvanized iron and cast iron down spouts.

Floors.—Sleepers; under planking; maple top flooring.

Underground.—Piping; tile and iron sewer pipe; galvanized and black standard wrought iron pipe; electrical tile conduits.

The above heads will also serve as a guide in obtaining costs of labor. Any architect who has had experience on this class of buildings can give unit prices both of material and labor, though an engineer on good terms with contractors can obtain more definite data on labor costs.

The number of working hours per day, and the average working days per year (this latter data should be taken for a number of recent years), together with the amount of work done per day by bricklayers and carpenters, comprise the data for estimating the time necessary for the completion of the buildings.

Equipment Data.

The class and capacity or size of tools pertaining to the different lines of product, should be listed and compared with the amount of product, as this will give an idea of the necessary new equipment. The speeds and power consumption of machines will be needed in determining size of motors for group driving, and also for individual motor drive. The percentage of tools running and the power consumption for the same will give figures from which may be deduced the new power plant requirements. The data of floor space occupied by the various tools are in the best shape for future use in the form of "dummies," cut from heavy cross-section paper to a scale of 3/16 or 1/4 inch to the foot, and including the necessary clearance space for withdrawing shafts, etc. These dummies, when laying out the location of the tools, are moved around on a floor plan drawn on the same scale cross-section paper. The cross-section paper facilitates the arrangement, as definite widths of gangways and clearances between tools, walls, columns, etc., are easily maintained.

Derivation of Base Units.

That, from the known floor space per man as a base unit, a modern highly efficient plant with but few buildings can be built to take care of the production of a large number of miscellaneous types of old buildings, is shown by the comparative tables, I to IV. Table I is made up from figures derived from all of the old buildings of the Allis-Chalmers Co. The intention was to build a new plant of approximately the same productive capacity as that of the combined old shops, and to have this new shop susceptible of methodical extension. The number of men in the machine shop and erecting spaces in the old shops are considered together, on account of the difficulty of allotting any definite amount of space per man to the erectors, the erecting space being a function of the space covered by the machine being set up, and of the time taken for its erection, rather than of the number of men. Approximately one-third of the number of men, together with the unit space figures per man, was taken from Table I to form a unit (Table II) better adapted for use in planning the four main buildings of the new plant. The machine shop space in Table III is but two-thirds of that in Table I, while the erecting space is approximately the same. The smaller floor space in the machine shop is due to the fact that the modern equipment with its high efficiency was expected to increase the efficiency of the machine shop about 50 per cent. Table IV is derived from Table II, and is placed side by side with it to make comparison easy.

BRITISH MACHINE TOOLS AT THE FRANCO-BRITISH EXHIBITION.

OSKAR KYLIN.*

In the English machinery section of the Franco-British Exhibition, which is now in progress in London, a few of the English machine tool manufacturers are presenting some types of their, generally, many different designs. Although not all of the machines exhibited, by far, possess any radically new features attracting the attention of the visitor, they still give a very good example of the present state of the English machine tool manufacture, and the general lines along which English makers are at present designing and building their tools. For this reason, a selection of some of the machines exhibited will undoubtedly prove interesting to American readers.

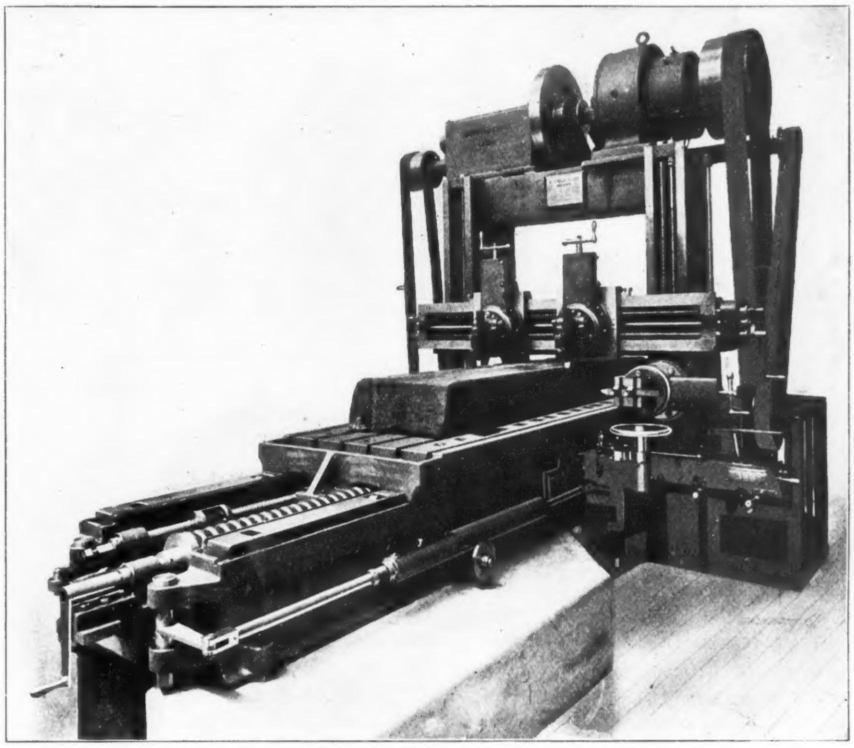


Fig. 1. Buckton & Co. Regenerative Reverse Planer.

Buckton Regenerative Reverse Planer.

Fig. 1 of the accompanying illustrations shows a heavy duty planer built by Joshua Buckton & Co., Ltd., Leeds. The difficulties of driving and reversing a heavy planer at a high speed without the consumption of excessive power is well known, and has been one of the most important problems in planer design since the introduction of high-speed steel. On account of the reciprocating motion, there is a large amount of kinetic energy which must be absorbed and redeveloped at each stroke. This absorbs an amount of power which was not determined until electric drives made its measurement possible. The sudden jump of the ammeter needle at the

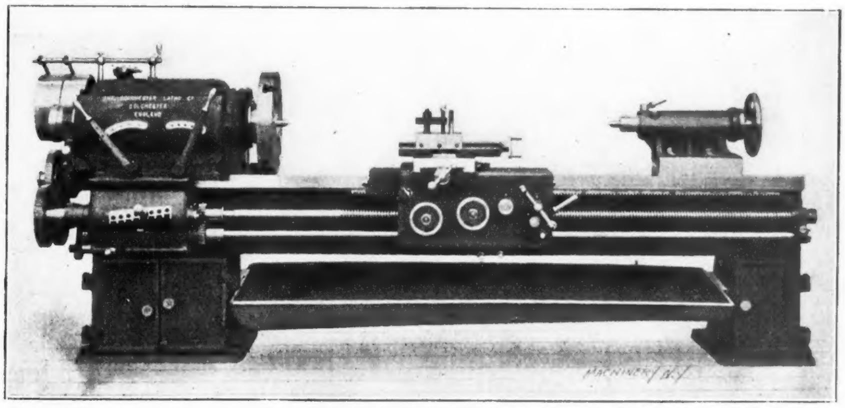


Fig. 2. Colchester Geared Head Lathe.

* Foreign Traveling Representative of MACHINERY.

point of reversal of a planer is well known, and every attempt to reduce the power consumed deserves consideration. The principle underlying the design of the Buckton planer is that of balancing the forces by recoil springs. These springs absorb a large amount of energy, and when the planer reverses, they restore, during the moments of acceleration, the energy which would otherwise be wasted. The planer shown is provided with a motor, the power of which need only be great

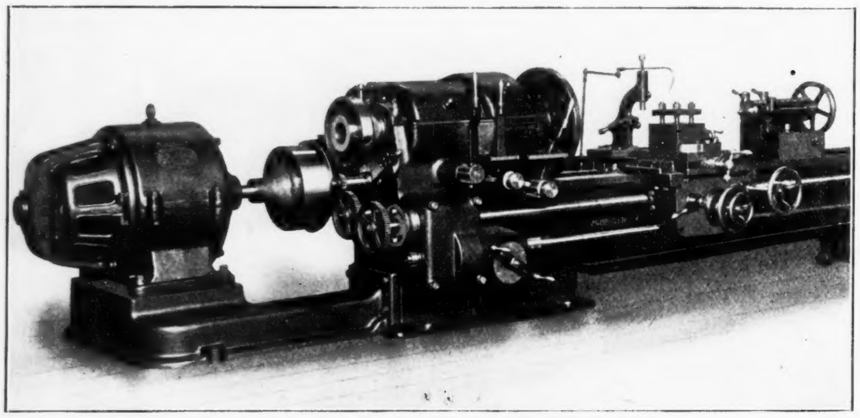


Fig. 3. High Speed Lathe built by John Stirk & Sons.

enough for taking the cut, there being no overload on the motor during the return stroke, although this is at the rate of 180 feet per minute. In the illustration, a large steel ingot is placed on the table; it is claimed that the weight of the work has no measurable effect upon the accuracy with which the planer is reversed.

The illustration plainly shows one of the recoil springs with which the planer is provided; another spring is placed in a similar position at the other end of the machine. During the stroke, the springs remain in the position shown, and abut against one of the cross bars of the bed. Two screws pass through these springs, and extend the whole length of the bed. On these screws are placed heavy adjustable bronze nuts, and against these nuts impinge brackets attached in fixed positions to the underside of the moving table, the impact being transmitted to the springs through the screws and suitable collars. By altering the position of the nuts upon the screws, any required length and position of stroke may be obtained; the minimum length of the stroke is 12 inches. There is nothing required for the changing of the length or position of the stroke except to turn the screws around so as to bring the nuts to the required location. The stroke can be adjusted while the machine is running. It will

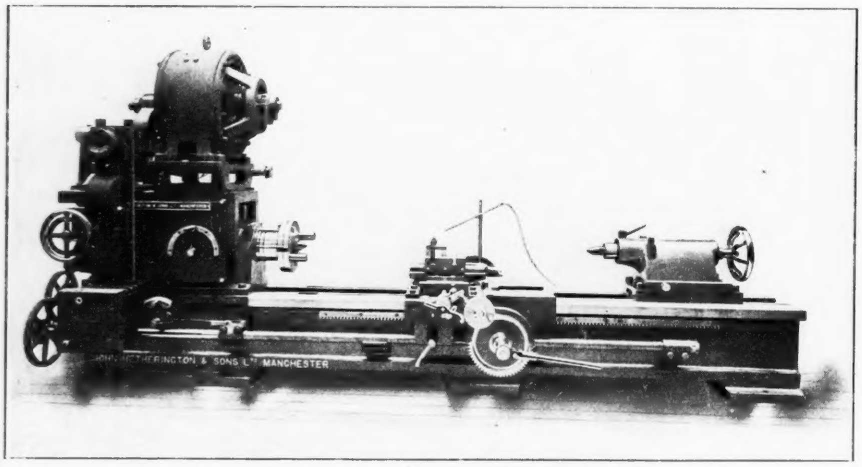


Fig. 4. John Hetherington & Sons High Speed Lathe.

be understood that while the return stroke of the machine takes place at a constant speed of 180 feet per minute, the cutting stroke can be varied by means of change gearing, the slowest cutting speed being 20 feet and the fastest 60 feet. In spite of the fact that the forward and return speed thus vary in the ratio of from 9 to 1 to 9 to 3, yet no adjustments are required for the spring action when using the fastest or slowest cutting speed. This is very important, because the danger in planers provided with spring buffers of any kind is that the amount of overrun is uncertain, and there is a danger of injuring the tool when planing up to a wall. It is claimed, however, that with the Buckton planer, under any circumstances, 1/8 to 3/16 inch is ample clearance.

Modern British Lathe Design.

The Colchester Lathe Co., Hythe, Colchester, exhibits a few lathes of which Fig. 2 represents the largest and most interesting one. The new patent geared head gives 18 spindle speeds which are obtainable by manipulating the levers conveniently placed for the operator. The mechanism consists of thirteen steel gears. In order to avoid all possibility of accidents, due care has been taken in the design of the head-stock so that it is impossible for more than one pair of gears to be in mesh at the same time. The driving pulley is 12 inches in diameter, and runs at a constant speed of 400 revolutions per minute. The head may be driven either direct from the main line shaft or coupled direct to a motor. One feature is that the carriage is made especially long, and is guided by a projecting strip or way which runs along in the front of the bed. This, the builders claim, makes it much easier to move the carriage, and eliminates the side strains which are present when the carriage is guided along the bed in the usual way. The number of feeds

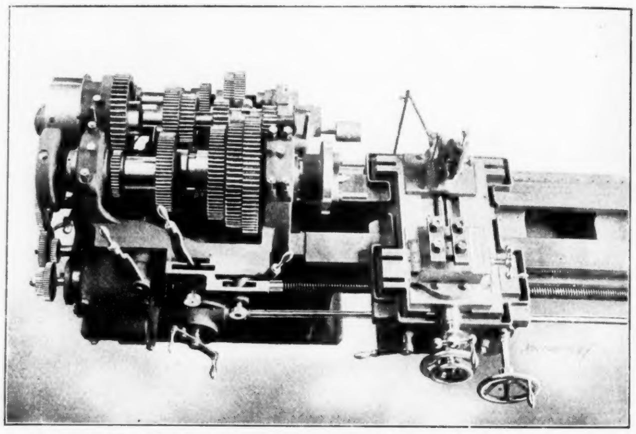


Fig. 5. The Head-stock and Carriage of Lathe shown in Fig. 3.

obtainable through the feed box shown in the illustration is 32, ranging from 0.125 to 0.008 inch per revolution. When the lathe is used for thread cutting, thirty-two different pitches of screws can be cut, ranging from 2 to 30 threads per inch.

In Fig. 3 is shown a 20-inch high speed lathe built by John Stirk & Sons, Halifax. The engraving shows the machine direct connected to a 30-H.P. motor, but it can also be belt driven direct from the line shaft, the only change required being to remove the motor. The pulley shown in the illustration between the motor and head-stock is employed in this case. The lathe, of course, is provided with geared head, permitting sixteen changes, giving spindle speeds from 10 to 250 revolutions per minute. As will be noticed from the engraving, the head-stock is cast in one piece with the bed for the sake of obtaining great rigidity. In Fig. 5 is shown the head-stock and carriage of this lathe, the cover over the geared head being removed so as to show the arrangement of the gearing. The feeds are all obtained from the gear box shown at the front of the bed below the head in Fig. 3.

John Hetherington & Sons, Ltd., Manchester, exhibit the 28-inch lathe illustrated in Fig. 4. The bed is made of a strong box section with two flat ways on the top provided with T-slots for locking the carriage and tail-stock. The

sliding rest is designed to swivel completely around, and is well secured to the carriage by three binding bolts. The geared head is driven by a direct connected motor mounted on the top of the head-stock. The machine, however, can also be driven direct from the line shaft. The number of spindle speeds obtainable is 24, arranged in geometrical progression.

Alfred Herbert, Ltd., Coventry, Exhibit.

The part of the machinery section of the exhibit which has the most of interest to offer to the visitor is the exhibit of

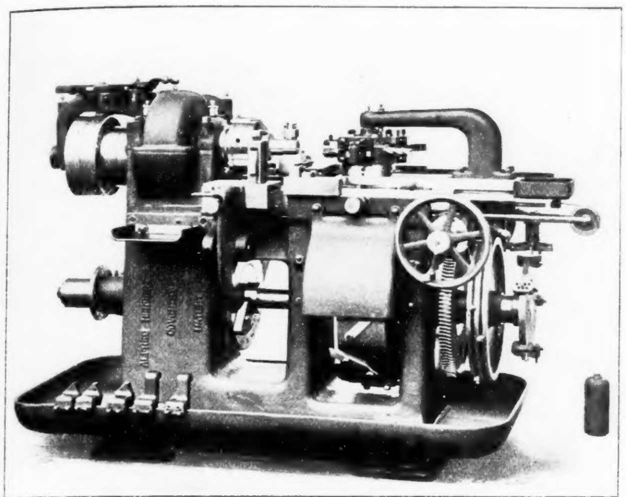


Fig. 6. Alfred Herbert, Ltd., Automatic Turret Lathe.

Alfred Herbert, Ltd. This famous English machine tool company presents a few of the types and sizes built. The machines are interesting, perhaps mainly because of the high class workmanship and their capacity in regard to output. The three different types of turret lathes built by the firm, the hexagon, the combination, and the capstan, are well represented by different sizes, and in order to give an idea of the

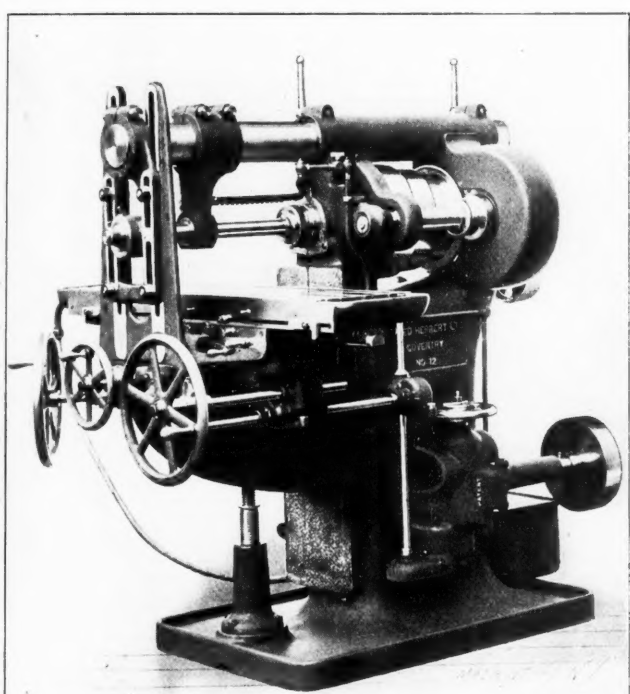


Fig. 7. Horizontal Plain Milling Machine, built by Alfred Herbert, Ltd.

class of work of which these machines are capable, samples of work are also exhibited. The representative machine of the turret lathe class is the No. 2 hexagon turret lathe which was illustrated and described in the March, 1907, issue of Machinery. Another machine exhibited by the firm is illustrated in Fig. 6, and represents the line of automatic turret lathes built. This class of machine is intended for working upon individual pieces of castings or forgings, or blanks previously cut off. The work is chucked by hand, but all the operations performed on the work are automatic including the stopping of the machine at the completion of its circle of operations. The head is driven by gearing and is exceptionally powerful. The pulleys provide either a two-speed automatic change, or a forward and reverse motion, according to the requirements of the work. The turret slide is adjustable to four positions, according to the length of the work operated upon, the turret slide drum having a corresponding adjustment. The turret has five faces, and is provided with a rigid over-head support. The cross slide in this machine is particularly wide, the object being to provide plenty of room for the tool-holders of various types, at both front and back.

The firm of Alfred Herbert is further exhibiting some vertical as well as horizontal types of milling machines. The

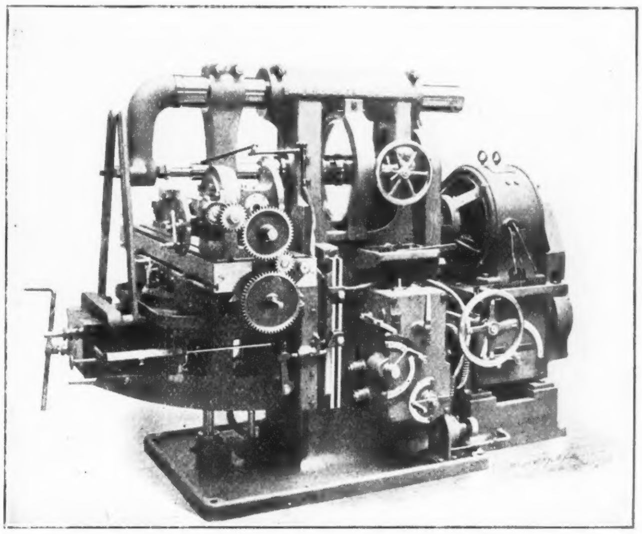


Fig. 8. Hetherington Universal Milling Machine.

engraving, Fig. 7, shows the horizontal plain milling machine on exhibition; the firm does not built universal milling machines. As seen from the illustration, the machine has cone pulley drive with double back gearing, permitting a great range of spindle speeds. The feed changing is accomplished by means of the Herbert patent dial feed motion of similar construction to the one used on the turret lathe and shown on the side of the column in the engraving, and the feed can be driven either independently or from the spindle. The firm recommends strongly the use of the independent drive for the feed. There is a drawback to driving the feed from the spindle, because the range of feeds becomes insuffi-

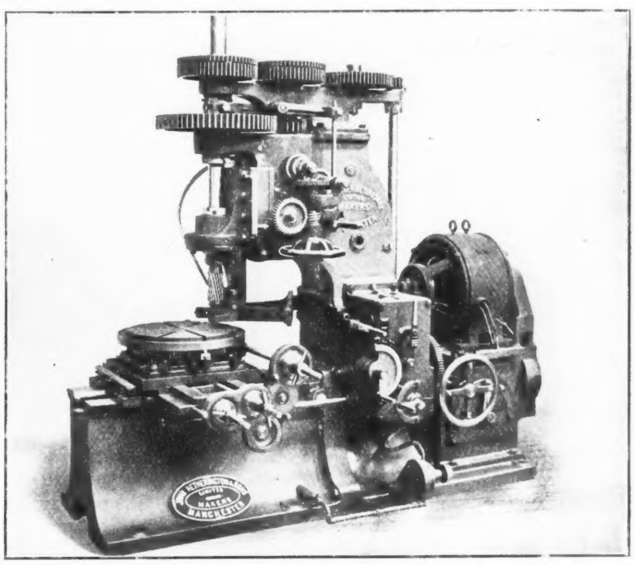


Fig. 9. Hetherington Vertical Drilling and Milling Machine.

cient for the slowest and fastest spindle feeds; for instance, for slow speed and large cutters, the feed cannot be obtained coarse enough, and for high speed and small cutters it cannot be obtained fine enough, at least for certain classes of work. By driving the feed independently, however, from the counter-shaft, this drawback is eliminated. The whole machine is operated from the front and does not require the at-

tendant to change his position and go around to the back. All the movements are governed by hand-wheels of sufficient size to permit easy action. It will be noted from the illustration that the drive of the feed from the gear box to the knee is not by means of the ordinary telescope tube shaft and universal joints, but by means of shafts at right angles.

The John Hetherington Exhibit.

We have already mentioned the geared head motor-driven lathe exhibited by John Hetherington & Sons, Ltd., Manches-

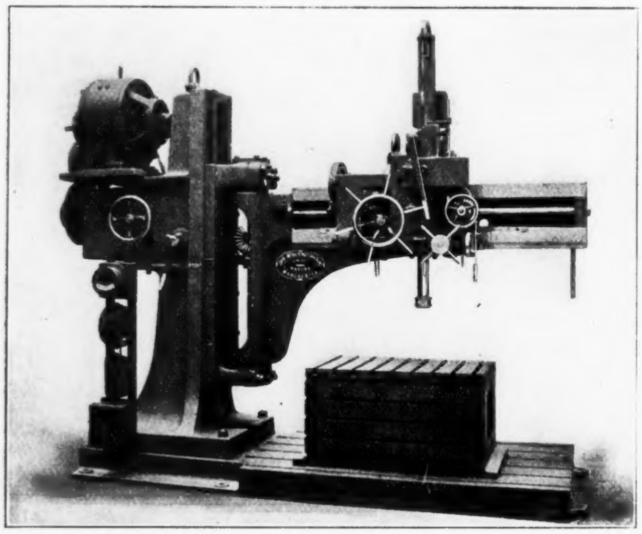


Fig. 10. High Speed Radial Drill, built by John Hetherington & Sons, Ltd.

ter. In Figs. 8 and 9 are shown two heavy duty milling machines exhibited by these makers. These machines are both of exceptionally heavy and powerful design, and are particularly intended for heavy work. As shown in the illustrations, these machines are driven by independent motors, but they are also built to be driven by constant speed belts and tight and loose pulley. The universal milling machine shown in Fig. 8 is provided with a geared drive, the spindle having 16 speed changes which are obtained by means of an index hand-wheel and levers. The feed motions are reversible and automatic, both for the vertical, traverse, and longitudinal

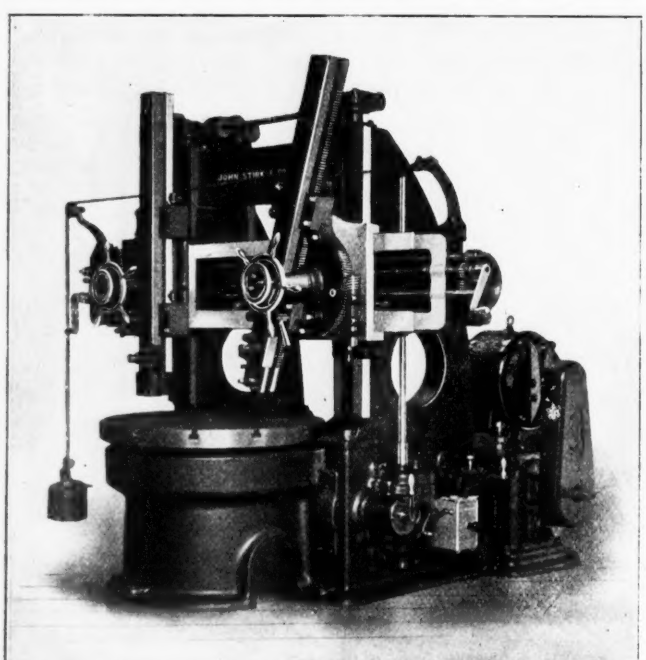


Fig. 11. Forty-eight-inch Vertical Boring and Turning Mill, built by John Stirk & Sons.

motions. The feed change is executed by indexing levers giving a feed variation of eight feeds to each spindle speed.

On the vertical milling and drilling machine shown in Fig. 9 also 16 different spindle speeds are provided, and there are also here eight feed variations to each spindle speed. In addition to the motions required for milling, there is also a positive and continuous drilling feed giving a variation of three feeds to each spindle speed.

This firm also exhibits the radial drill shown in Fig. 10. This machine is driven by a 14-H.P. motor, mounted as shown in the illustration, but, of course, can also be driven by a constant speed belt. The cone box for changing the spindle speeds without stopping is operated by the index hand-wheel shown in the front of the frame under the motor. The spindle is fitted with clutch reverse motion, and with speed changing device for reducing the speed for tapping. The machine is also provided with a quick hand traverse for running the spindle to and from the work. The radial arm is supported on a ball bearing and can swing through an arc of 180 degrees, the minimum radius being 3 feet, and the maximum 7 feet.

John Stirk & Sons' Exhibit.

In Fig. 11 is illustrated a vertical boring and turning mill manufactured by John Stirk & Sons, Halifax, builders of the high speed lathe already described and illustrated in Figs. 3 and 5. This 48-inch vertical boring mill is driven by a direct connected 13-H.P. motor. The tool-holders are provided with swiveling slide and counter-balancing arrangement; independent automatic positive feeds are provided for

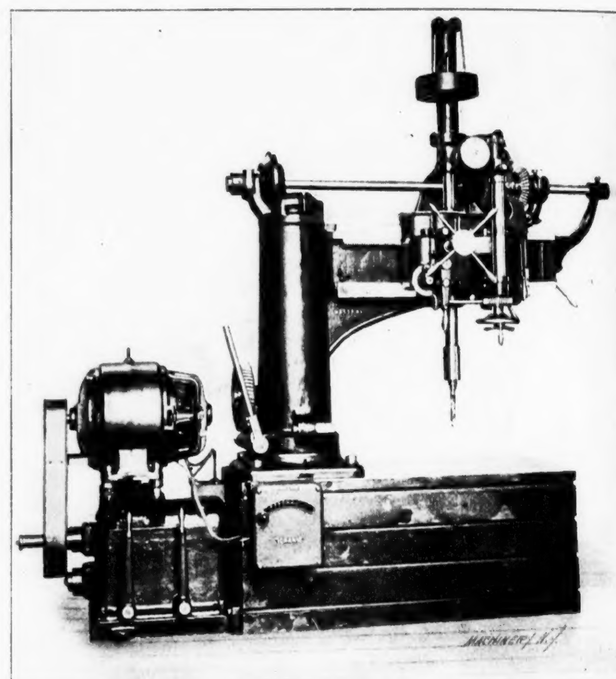


Fig. 12. High Speed Radial Drill, built by John Stirk & Sons.

each of the two slides, nine changes of feed being obtainable in any direction. The drive of the machine is through a gear box giving eighteen changes of speed, the final motion to the table being through a multiple thread worm and gear; this ensures a perfectly steady drive. The table speeds vary from approximately 1 to 50 revolutions per minute. The general design of the machine throughout is typically English.

The same firm is also exhibiting the radial drill shown in Fig. 12. This machine is designed especially for the use of high-speed drills, and is driven by a direct connected 13-H.P. motor. The arm can be swung around on a pivot of large diameter in a complete circle. When in its lowest position, it rests on steel balls, but it can be raised 12 inches if required. The carriage is moved on the arm by rack and pinion in the usual manner. The reversing motion consists of a combination friction and positive clutch of unique design for which patents are applied for. The drive is through a gear box, giving nine changes of speed, which can be operated without stopping the machine. A back gear arrangement on the carriage doubles the number of speeds to 18, varying from 13 to 560 revolutions per minute. The gear box forms a receptacle for oil, the gears thereby running constantly lubricated. The manufacturers guarantee that this machine will drill one-inch diameter holes in mild steel at a rate of 9 inches feed per minute. The approximate weight of this machine, including the motor, is 10,000 pounds.

GEAR-CUTTING MACHINERY—9.

RALPH E. FLANDERS.*

This, the concluding installment of the series of articles on gear-cutting machinery, continues the discussion of methods of cutting bevel gear teeth with special reference to machines which act on the molding-generating principle.

Molding-Generating Machines Employing the Milling Operation for Cutting the Teeth of Bevel Gears.

One of the most interesting and ingenious of all the machines for cutting the teeth of bevel gears is that shown in

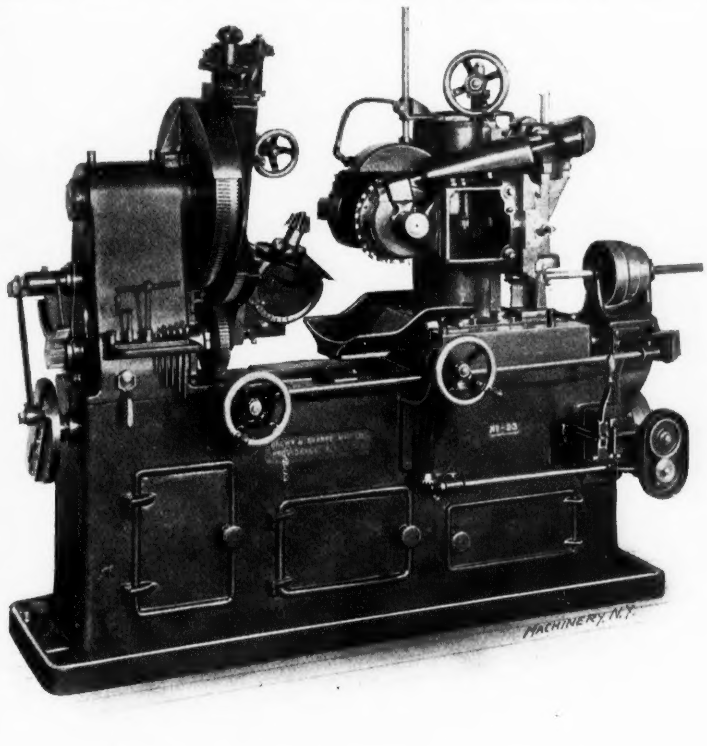


Fig. 171. Brown & Sharpe Beve Gear Generating Machine, cutting the Teeth by the Use of Interlocking Milling Cutters of Large Diameter.

Fig. 171. It operates on the principle shown in Fig. 140, in which the sides of the crown teeth are represented by the plane faces of milling cutters. In this machine the milling cutters and the imaginary crown gear remain stationary so far as position is concerned, though, of course, the cutters revolve about their own axes. The work is held in the spindle of a head (resembling the universal head of the milling machine) which is mounted on the slide of a swinging sector at the left, which sector is rocked about a horizontal pivot in line with the axis of the imaginary crown gear. The work spindle and the rocking movement of this sector are so connected by change gearing that, as the latter is oscillated through a sufficient angle to generate the teeth, the work is rolled in the proper ratio to mesh with the imaginary crown gear, a tooth of which is represented by the milling cutters. This movement, referring to Fig. 139, is thus seen to be identical with the case in which the crown gear is stationary, while the frame is rocked, rolling the master gear on the crown gear, and the work over the tool.

The cutters used are of large diameter in proportion to the work for which the machine is intended, in order to minimize the deepening of the tooth space at the center which is characteristic of a gear cut in this way, as was explained in connection with Fig. 140. It will be seen that the teeth of the two milling cutters are set so as to interlock. In this way comparatively stiff cutting blades may be made to represent a complete crown gear tooth of very fine pitch.

The machine is universally adjustable within its range. The cutter spindles may be set to give teeth of greater or smaller pitch, and to work with gears of large or small pitch cone radius. They may also be adjusted for teeth of greater or less angularity than the $14\frac{1}{2}$-degree standard involute generally used. The details of the mechanism of this machine are very interesting, but there is space here only for this description of its action. The Brown & Sharpe Mfg. Co., Providence, R. I., is the builder.

In Figs. 172 and 173 are shown views of two sides of the Warren bevel gear generating machine, first developed and built, if the writer's memory serves him, by the Pratt & Whitney Co., of Hartford, for the manufacture of chainless bicycle gears. The machine we show, however, is a design built for general manufacturing use by Ludwig Loewe & Co., of Berlin, Germany. This machine is approximately similar in its action to the one built by Brown & Sharpe, and just described. Aside from the differences in the mechanism, however, there are two important differences in its action. One is the fact that the two cutters do not cut on opposite sides of the same tooth, but on facing sides of alternate teeth, leaving a whole tooth untouched between them. The independent slides in which they are set are so arranged as to allow the plane cutting face of the cutters to be set to agree with the corresponding faces of the imaginary crown gear. The other difference is the means taken to cut a tooth space having a straight bottom, with cutters of small diameter. This is done by making the rolling of the cutter holder and the blank on each other a continuous rocking movement at a quite rapid rate. During this rapid rocking, the cutter slides are fed inward on their respective guides to form the sides of the particular teeth at that time presented to the cutters.

The cutter slides and guides are mounted on a circular head, which is rocked about the axis of the imaginary crown gear by the slotted crank and link seen at the side of the machine in Fig. 173. The upper end of this circular slide carries a segment of a crown gear, which meshes with the corresponding segment of a master gear on the work spindle, this arrangement being very similar to that of the Gleason machine shown in Fig. 170. The work and the cutters being thus rapidly rocked about each other while the cutters are slowly fed down through the tooth spaces, the sides of the teeth exposed to the action of the cutters are properly formed to the theoretical tooth curves. As in

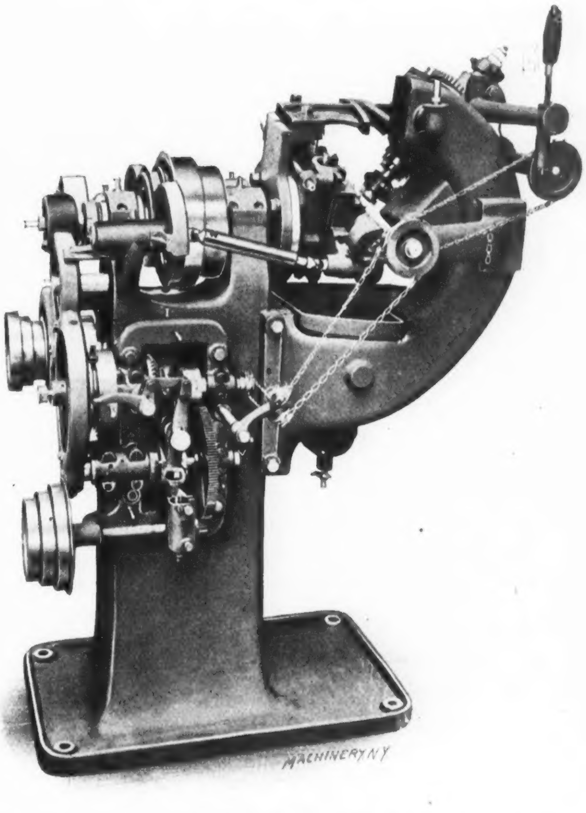


Fig. 172. The Warren Bevel Gear Generating Machine as built by Ludwig Loewe & Co., Berlin.

the previous case, there is no space here to go into the ingenious construction of this machine, with its provision for

* Associate Editor of MACHINERY.

automatically effecting all the movements for rocking the cutter slides and the blank, feeding downward and returning, indexing, etc.—nor for following out in detail the various adjustments provided for cutting gears of all kinds within the range of the machine.

Bevel Gear Cutting Machines using a Hob and Operating on the Molding-Generating Principle.

While the hobbing principle is easily and simply applied to the cutting of spur and spiral gears, as illustrated in Figs. 50 and 96, it requires but little thought to show that the appli-

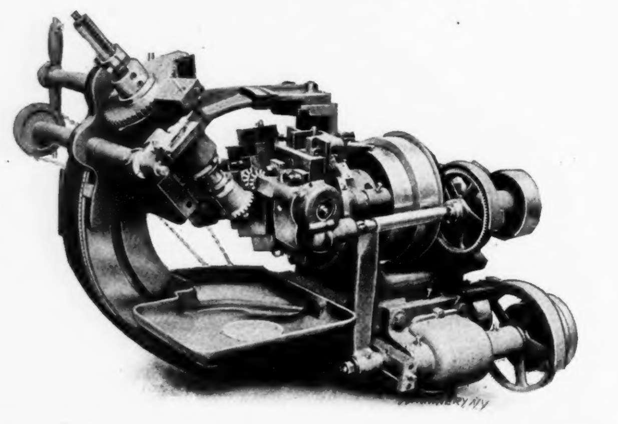


Fig. 173. The Working Side of the Warren Machine showing the Milling Cutters whose Plane Surfaces represent Sides of Adjacent Crown Gear Teeth.

cation of the same principle to the cutting of bevel gears is a difficult, if not hopeless, task. Nevertheless, this problem has been attacked in two different directions. The principle of the mechanism and tools employed, however, requires to be studied with greater care than in the case of any of the machines we have previously described, if the reader is to have a clear understanding of their method of operation. The first of the two processes is that developed by M. Chambon, of Lyons, France. The operation of the machine is dependent on the principle of the hob, whose generation and finished form are illustrated in Figs. 174 to 178, inclusive.

In Fig. 174 is shown the basic principle of the molding-generating process applied to the cutting of bevel gears, identical in its essentials with the mechanism shown in Fig. 139,

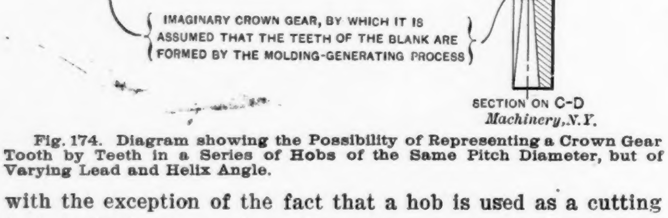


Fig. 174. Diagram showing the Possibility of Representing a Crown Gear Tooth by Teeth in a Series of Hobs of the Same Pitch Diameter, but of Varying Lead and Helix Angle.

with the exception of the fact that a hob is used as a cutting tool, instead of a reciprocating planer tool. At the left of the engraving a face view of the crown gear is shown. The width of the top of the tooth at the outside diameter is W, at the inner end of the tooth w. A hob may be made, such as No. 1, having teeth whose shape on a normal section EF exactly matches the same section of a tooth of the crown wheel when the teeth of both are centered on line CD, and the hob is set at the helix angle θ. Under these circumstances, a tooth of the hob would have a width W at the top. If the hob is single-threaded, and the crown gear has, for instance, 24 teeth, the two may be revolved together, the hob making 24 revolutions to one of the crown gear. Then this tooth of the hob, which comes into action at the time it is central with line CD, will exactly match the outline at the larger end of each of the teeth of the crown gear in turn, as it revolves. To have a hob which would similarly match the teeth at the smaller or inner end, we could construct one of the same diameter and of smaller pitch, smaller helix angle θ', and a corresponding width of flat, w, at the top of the tooth, all to correspond with the shape of the inner end of the crown gear tooth. It also should revolve in the ratio of 24 to 1 with the crown gear, and the tooth which comes central with the line CD at each revolution may be made to match accurately with the outline of the inner end of the tooth. In the same way, hobs may be made to be used at any intermediate point in the length of the tooth of the crown gear, so that one of the cutting edges will match the outline of the tooth at this point, once for every revolution of the hob. The problem is to construct a single hob which will do the work of hobs No. 1 and No. 2, and of all possible intermediate hobs between the two positions.

In Fig. 175 the two hobs of Fig. 174 are shown enlarged. As previously explained, they are of the same diameter, with

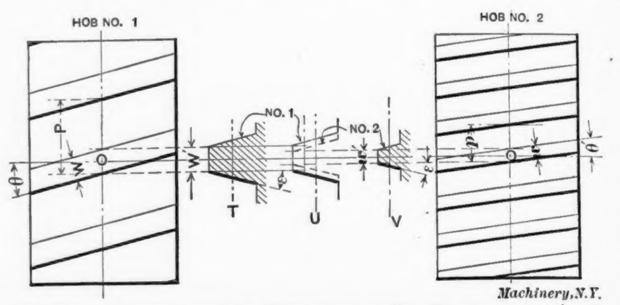


Fig. 175. Comparison of the Hobs representing the Large and Small Ends of the Crown Gear Tooth in Fig. 174.

the normal width at the top of the teeth W and w, the same as that of the large and the small ends of the tooth of the crown gear, and with the leads of each, P and p, as required by the pitch of the large and small ends of the teeth. This gives corresponding angles, θ and θ' in the two cases. At T and V are shown axial sections of the thread for hobs Nos. 1 and 2. Since T and V correspond to the large and small ends of the teeth of a crown gear, the widths W' and w' are proportional to the leads P and p, and the angle of inclination of the sides, ϵ, is the same in each case. What we have to do now is to combine Nos. 1 and 2 into a third, which will do the work of both of the previous ones.

Suppose we take a blank of the same diameter as the two hobs in Fig. 175 and thread it first with the same shape and pitch of thread as for No. 1, and second with the same pitch and shape as for No. 2, except that while the width of the top and the inclination of the sides remain the same, the cut will be carried to the full depth required for the thread of No. 1. As shown at U, in Fig. 175, the dotted section of No. 2 is the same as for V, except for its increased depth. When the hob has been thus threaded, the developed circum-

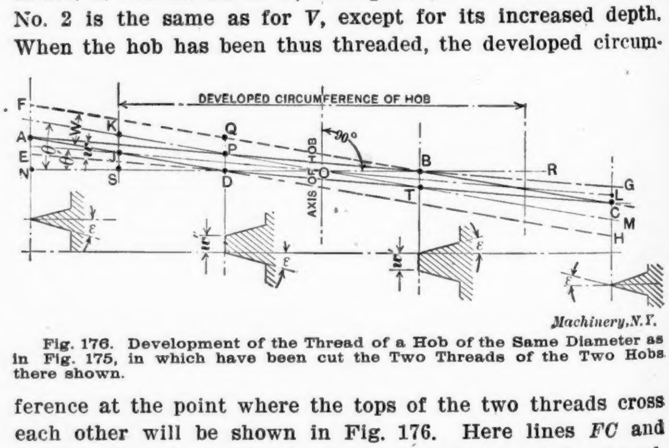


Fig. 176. Development of the Thread of a Hob of the Same Diameter as in Fig. 175, in which have been cut the Two Threads of the Two Hobs there shown.

ference at the point where the tops of the two threads cross each other will be shown in Fig. 176. Here lines FC and AH represent the top of thread No. 1, inclined at the threading angle θ as determined by the pitch, while the space included between lines AG and EC correspondingly represents the top surface of thread No. 2, inclined at angle θ'. These two threads have widths at the top of W and w, proportional to the pitch as before. The center lines of the tops of the two threads cut in the blank cross each other at point O. The top of the thread is seen to be cut in a parallelogram $ABCD$, this being the metal left after the grooves for the two different

threads have been cut. Axial sections of this remaining fragment of the thread are shown on lines *FN*, *QD*, *BT* and *CH;* as may be seen, the inclination of the sides of the thread, as measured on an axial section at each of these points (and at all other points as well) is made ϵ.

A short hob, threaded as in Fig. 176, is shown in Fig. 177. Similar points in each figure have similar letters. Since the two sides of the teeth, which unite in point *B*, have the same inclination as measured on a plane passing through the axis of the hob, their intersection will also have the same inclination, and the line of intersection will pass through the axis of the hob. The same is true of point *D* on the other side of the thread. If the hob is gashed at *B* and *D*, the cutting edges thus formed are evidently common to both the large thread of width *W* and angle θ, and the small thread of width *w* and angle θ', and when properly set in the machine and rotated

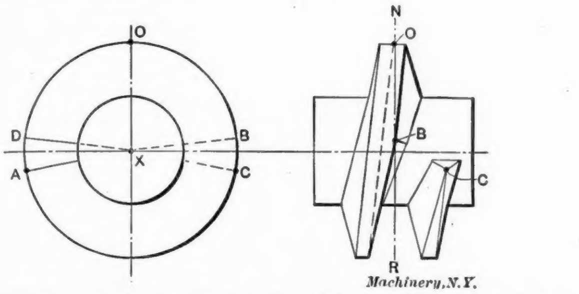


Fig. 177. Hob (ungashed) Produced by Combining the Two shown in Fig. 175; the Thread is the same as that shown Developed in Fig. 176.

with the crown gear, the relation to the imaginary crown gear will correspond exactly to that gear in the position of either hob No. 1 or No. 2, in Fig. 174, the same hob thus taking the place of both.

It next remains to be shown that these two cutting edges at *B* and *D* in Fig. 177 can be made to correspond with all the sections of the crown gear intermediate between the large and the small ends in Fig. 174.

To prove this, we have to show that the sides of any thread cut in this hob with a center line passing through *O*, whose width of top and lead are in the same proportion as in Fig. 175, and whose sides have the same inclination as measured on an axial plane, will include the cutting edges *B* and *D*, which we have formed as described in the hob in Fig. 177. In Fig. 176 any thread of the given proportions, such as *FCAH*, will cut the horizontal line *NR* at *D*, in such a way that $OD : OS = DP : KS$. Now *DP* is half the width of the tooth on the axial section, and *KS* is half the circumferential pitch, so that $OD : OS = \frac{W'}{2} : \frac{P}{2} = W' : P$. But all the threads we are concerned with have this same ratio between W' and *P*, so that the sides of all of them cross line *RS* at *D*.

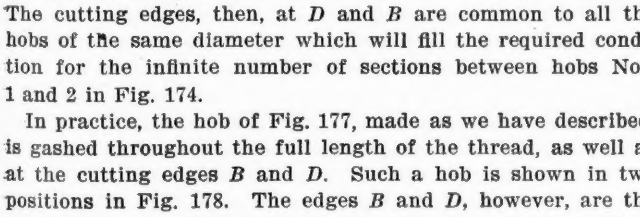


Fig. 178. The Completed Hobs as used in the Chambon Machine, Developed as shown in the Preceding Illustrations.

The same thing applies to the crossing at *B* on the upper side. The cutting edges, then, at *D* and *B* are common to all the hobs of the same diameter which will fill the required condition for the infinite number of sections between hobs Nos. 1 and 2 in Fig. 174.

In practice, the hob of Fig. 177, made as we have described, is gashed throughout the full length of the thread, as well as at the cutting edges *B* and *D*. Such a hob is shown in two positions in Fig. 178. The edges *B* and *D*, however, are the ones which are relied on to give the true shape to the teeth of the gear.

The next problem, and a somewhat complicated one, is that of providing a machine which will utilize this hob, in accordance with the principles of its construction, to take the place of the imaginary crown gear of Fig. 174 in generating teeth in a bevel gear blank. In the first place, the hob must be moved from the position occupied by No. 1 to that occupied by No. 2, changing its angle continuously meanwhile from θ to θ' to agree with the change in helix angle due to the change of pitch as the tooth grows smaller. Next, the hob and the blank being cut must be rotated with each other, so that the hob revolves during one revolution of the gear as many times as there are teeth in the latter, the hob being supposed to be single-threaded. These two conditions are easily fulfilled, but there still remains a third. The two cutting edges we have made for the hob represent the sides of each tooth of the imaginary crown gear only when each tooth in turn is passing the center line *CD*. In order to have a generating action on the blank, the imaginary teeth of the crown gear must have a cutting action over a considerable angle about *D*, on both sides of the section *CD*. This may be effected by rocking the holder which carries the hob about center *D* in either direction, meanwhile rotating the hob to keep its thread in the proper relation with the teeth of the crown gear, as if the latter was stationary. In the machine this oscillation of the hob and its carrier about *D*, on each side of *CD*, takes place continuously, while the hob is being fed down from the position occupied by No. 1 to that of No. 2, and the rotation of the hob required by this oscillation (to keep the hob and the crown gear continuously in step) is superimposed on the other rotation in unison with the imaginary crown gear and the

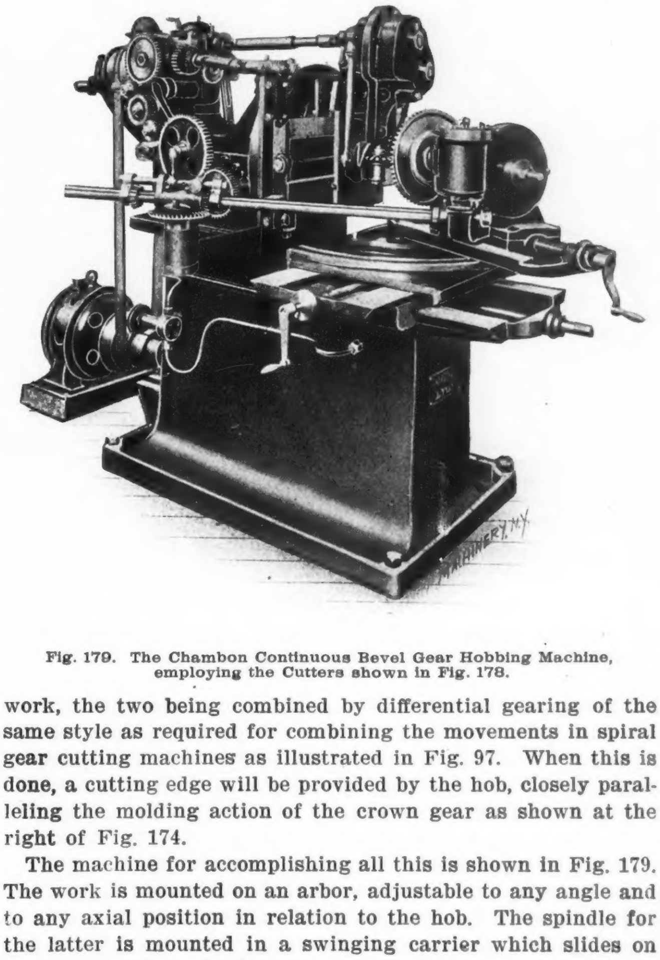


Fig. 179. The Chambon Continuous Bevel Gear Hobbing Machine, employing the Cutters shown in Fig. 178.

work, the two being combined by differential gearing of the same style as required for combining the movements in spiral gear cutting machines as illustrated in Fig. 97. When this is done, a cutting edge will be provided by the hob, closely paralleling the molding action of the crown gear as shown at the right of Fig. 174.

The machine for accomplishing all this is shown in Fig. 179. The work is mounted on an arbor, adjustable to any angle and to any axial position in relation to the hob. The spindle for the latter is mounted in a swinging carrier which slides on ways provided on the face of a head, which latter is oscillated about a horizontal axis. A suitable compensating movement is provided, so that this rocking movement is translated into the required rotary motion of the cutter, as was shown, to keep it from getting out of step with the imaginary crown gear, and for combining it properly with the constant rotation of the cutter, derived from its connection with the work-revolving mechanism. The spindle carrier feeds in along the ways of the oscillating head, being swung around by a templet as it proceeds, to change the helix angle θ as required. Suitable change gears are provided for all the movements, and one passing through of the continuously rotating hob finishes the gear complete. The mechanism is rather too

intricate to describe here in detail. A number of compensating movements are required, which add somewhat to its complexity.

We should not leave the discussion of this machine and its principle, ingenious though it is, without noting that the process involves a number of minor inaccuracies. For one thing, an error is introduced by the fact that in the machine the rocking of the spindle-head, carrying the hob, is about the axis *X'Y'*, instead of about axis *XY*, as it should be. (See Fig. 174.) This is doubtless done to avoid the complication of having to set the machine for the angle of the top of the crown tooth. The error introduced would be entirely negligible, except perhaps in the case of gears very closely approaching crown gears in their pitch cone angle. There are several other little discrepancies which, however, are scarcely worth taking into account.

In Fig. 180 is shown another machine operating on the Chambon plan, built by the Société Suisse pour la Construction des Machines-Outils Oerlikon, Oerlikon près Zurich, Switzerland. This machine employs the cutter in Fig. 179, but the mechanism is very much simpler, since the oscillating head and the connections required for operating it have been abandoned, the spindle slide being mounted directly on fixed ways on the front of the column. For this reason the generating action is not, it will be seen, fully carried out, the cutting action, however, resulting in the production of a groove tapering properly from the large to the small end and of approximately the correct shape. The machine is thus especially adapted to roughing blanks previous to finishing them in a planing machine operating on the templet or molding-generating principles. It is claimed to do its work with great rapidity, and to be capable of leaving a very small and uniform amount of stock over the whole area of the sides of the tooth.

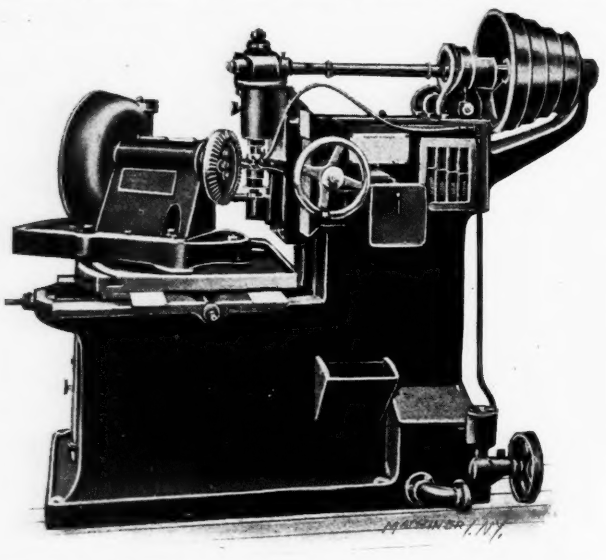


Fig. 180. The Chambon Bevel Gear Hobbing Machine as Developed by the Oerlikon Co., particularly adapted for Roughing Bevel Gears Preliminary to Planing.

Besides this Chambon process, another and, it seems to the writer, a fruitless attempt, has been made to cut the teeth of bevel gears by the molding-generating principle with a hob as the cutting tool. This method is shown in its principle in Fig. 181, the construction being referred to the imaginary crown gear and the bevel gear to be cut, as in the previous case. Also, as in the previous case, the action hinges about the design of the hob. Here we have a hob of such a taper, and with the pitch continuously decreasing in such a ratio, that the helix angle is constant. This decrease in pitch is, of course, accompanied by a correspondingly uniform and proportional decrease in the section of the thread. In the machine the hob is so set (in the "first position," for instance) that the center line of the thread in the cutting position passes through center *D* of the imaginary crown gear. Here the width of the top of the hob tooth is *W*, corresponding to the desired width at the top of the imaginary crown gear tooth. In feeding, the hob is moved, without changing the angle of its axis, along line *EF*, so that when it arrives at the inner end of the face of the imaginary crown gear, that tooth that is on the center line *CD* will be so near the small end of the hob that it has the required width at the top, *w*, and the proper pitch, to agree with the small end of the tooth in the imaginary crown gear. In a similar way, all the intervening positions match up with the teeth of the crown gear on line *CD*.

In the machine for utilizing this hob (which has been referred to in a number of English papers and described in an American contemporary*), it is mounted on a slide which is adjustable to give the line of feed, *EF*, the angle for the conditions required, while, as shown at the right of Fig. 181, the spindle of the hob is set at such an angle that its pitch cone is tangent to the pitch plane of the imaginary crown gear. The feeding movement along line *EF* is so connected with the rotating mechanism of the hob that, as it progresses from the first to the second position, the hob is rotated to keep its diminishing thread always coincident with the central tooth of the crown gear shown. In addition to the rotation thus given the hob by the feeding movement, another rotating movement is given it in connection with the work, the same as for all hobbing processes. These two rotating movements are combined by differential gearing. It will thus be seen that with the machine properly set up, the hob may be fed from the first to the second position, with the hob and work rotating together, the former being under a rotative influence from the feeding movement as well, giving somewhat the effect of the rotation of the ordinary crown gear.

What the writer feels sure, however, is a vital error in the principle of this machine, is plainly evident in Fig. 181, where it is seen that the only point where the teeth of the hob coincide with those of the imaginary crown gear is on line *CD*. At the right of *CD* and at the left of it the coincidence ceases, and the hob teeth cross the crown gear teeth at different angles, so that they must cut entirely different shaped spaces in the work. Of course, everything in the diagram shown is exaggerated, but the exaggeration only shows the principle more clearly. While it is stated that the machine and the process are beyond the experimental stage, and while, from long experience, the writer knows that it is unsafe to predict the failure of any principle until it has actually

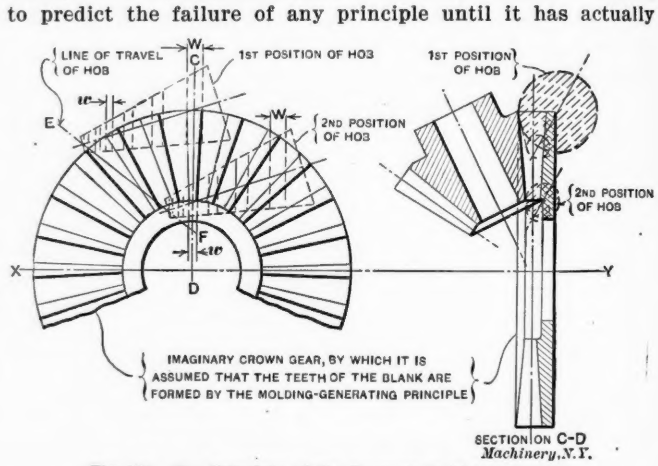


Fig. 181. The Principle of the Bostock Hobbing Process.

been tried out, the analysis given above is surely enough to make one skeptical as to the success of this operation, particularly in the case of gears of such large pitch cone angle as to nearly approach the crown gear. With smaller angles, down to the spur gear the action should be more nearly correct, as the blank curves away from the hob so rapidly as to avoid most of the interference, though even here the fact that the pitch is coarser at one side of the line *CD* than at the other would still prevent proper action. It would thus seem that interference would prevent the consideration of this device as a practical possibility. The inventor of this machine is Mr. F. J. Bostock, Birmingham, England.

Comparison of Molding-Generating Machines for Bevel Gears.

It is interesting to note, in the various molding-generating machines for bevel gears, the different ways used for rolling the cutter head and the work in relation to each other. In the Bilgram machine the proper relation is maintained by

* American Machinist, March 5, 1908.

the rolling of the pitch surfaces of the work and the crown gear on each other, the rolling being controlled by steel tapes or wires in such a way as to make the movement positive. In the Ducommun machine the same movement is effected by spherical linkage which, while not exact in its action, is so nearly so that the error introduced is entirely negligible. The Gleason and Ludwig Loewe machines employ segments of the actual crown and master gears shown in Fig. 139, although, of course, it is not necessary to have the teeth of the master gear of the same number for the full circle, and of the same form, as those of the work, the only requirement being that the pitch cone of the master gear be coincident with that of the work. In the Ernault machine the proper ratio of movement is obtained by a system of angular slides, which automatically adjust themselves to the required ratio (which is dependent on the pitch cone angle of the gear) in the manner described in referring to Fig. 169. Finally, in the Brown & Sharpe, Chambon, and Bostock machines the proper ratio is obtained by the use of change gears.

Another interesting point relates to the considerable size and complication of each of these machines, as compared with the small size of the work they are adapted to operate on. While the principle of the molding-generating process is comparatively simple, as shown in Fig. 139, considerable mechanism is required for making a machine built according to this principle universal in its application, easily set up and operated, and automatic in its operation.

Conclusion.

This concludes this series of articles on gear-cutting machinery. The number of commercial machines of this kind is much greater than was believed possible when the series was first undertaken. It is safe to say that in no other field of the machine tool business has there been such an opportunity for the display of mechanical ingenuity and skill in designing as in that of gear cutting, and in no field have these possibilities been so fully grasped. That we have not yet reached final development in any of the various forms of this machinery is shown by the fact that the past year has been particularly prolific in new designs, as may be seen from an inspection of the New Tools Department of the various issues of MACHINERY since January, when the series was commenced. Besides these, a number of new machines are in process of development in this country and Europe, and doubtless such as are worthy of mention will be brought to the attention of the readers of MACHINERY as soon as the information concerning them is available for publication.

* * *

SUPERHEATING IN ENGLAND.

BRITISH CORRESPONDENT.

The opinions and experiences of engineers in the north of England engineering and manufacturing districts on the important subject of superheating are briefly summarized below, and may interest American readers, who will be able to compare them with American experience and with the opinions of American experts. The economy which may be attained by superheating is now freely recognized in England, and although a great deal has yet to be learned respecting the nature of steam, the majority of steam users now exhibit less fear in the adoption of a practice which after its introduction for a time was received with disfavor. The actual steam users are not the only ones interested in superheating. Boiler and steam engine makers in England are fully alive to the fact that if steam engines are to successfully compete in efficiency with internal combustion motors, they must cooperate with each other with the object of securing the utmost possible percentage of heat units from every pound of coal put into the boiler furnaces. Even English colliery owners, who are not usually particular in the matter of fuel economy, are now beginning to recognize the fact that superheating offers too great a saving to be ignored.

In the case of gas engines, the size and the power of which are now steadily increasing in England, the problem of using the operative fluid is a comparatively simple one, and that probably accounts, to a large extent, for the success of this type of prime mover; but in the case of the steam engine, the fact that the steam may be gradually reduced to a liquid state during its stages of operation introduces risks of loss, which it has been the constant aim of engine builders to minimize, ever since the time of Watt. Multiple expansion has now been extended to its utmost limit; steam jacketing and reheating are only means to an end. Apparently, therefore, the only course left is to convert the steam temporarily into a gas by giving it such a degree of heat that there is no possibility of its condensation while passing through the cylinders of the engine. Condensation represents the principal source of loss in all reciprocating steam engines, and means of preventing it other than by superheating can only be regarded as palliatives. But it is not for reciprocating engines alone that superheating is found to pay. In the turbine engine, largely used in England in electric lighting stations, although the condensation of steam by cold external surfaces does not take place, it has been proved that superheating is an advantage. The steam in the turbine, as Prof. Watkinson, a well-known expert, has pointed out, is wet from another cause, namely, on account of the expansion it has undergone while doing work; consequently, the efficiency of this type of prime mover may be very considerably increased by superheating the steam prior to its admission to the steam chest. In the steam turbine the reduction in the amount of steam required when superheated is mainly due to the increased volume and the decreased frictional resistance between the rotating vanes and the steam. In one type of turbine in which the steam is discharged through nozzles, the flow has been found to vary or fluctuate, which is asserted to be due to partial choking of the nozzle with water. When the steam was superheated, the flow was found to be continuous and unvarying, to have a higher velocity, and consequently a much greater efficiency.

The soundness of the practice of superheating being therefore easily demonstrable, the question that faces the steam user is one of degree. It is generally understood in England that in the United States they are very conservative in regard to superheating, a "moderate superheat" being understood to mean from 100 to 150 degrees F. at the boiler, or about 100 degrees F. at the engine. This is considered in England a somewhat too moderate degree, which may probably entail reheating between the high-pressure and the low-pressure cylinders. In England, many engineers are not afraid of using higher temperatures. The engine builder is prepared for them, and the engineer is not afraid of his packings burning out or of his lubricants carbonizing. In consequence, no practical difficulties are encountered in superheating to a considerably higher extent. At the same time, it is very essential that the temperature of the superheated steam should be constant.

Early difficulties with the superheating tubes have also been overcome. Solid drawn steel is now being generally adopted in England in place of copper and cast iron, and the apparatus is therefore not only safer, but its life approximates more nearly the life of the boiler itself. The large English steam user, when invited to consider superheating, naturally asks what he may expect to save by it. On this point experiences vary very considerably, and the figures given by the makers of superheaters are subject to some discount. In a paper read some time ago before the Sheffield Municipal Electrical Association, Mr. R. S. Downe stated that, with a superheat of 500 degrees F., he could effect a saving in coal and steam amounting to between ten and twenty per cent. The saving is, of course, greater where the engines are working under uneconomical conditions, and where steam jacketing is used, or where the piping is inordinately long. A superheater attached to a boiler may abstract ten per cent of the heat in the flue gases, and reduce the efficiency of the boiler by something like the same figure, but as this extra ten per cent heat in the steam may reduce the engine losses by twenty per cent, the net gain is a substantial one, and justifies the adoption of superheating in the opinion of English users. Mr. Downe finds that the saving in steam is greater than the loss in coal, which is, of course, due to more fuel being required to obtain the superheat.

It is stated that 100 degrees F. of superheat in the steam turbine gives an extra economy of 12 per cent, and it has been estimated at 20 per cent with 350 degrees of superheat.

Superheating in the turbine secures dry steam, and freedom from the clogging of the blades and guides by water.

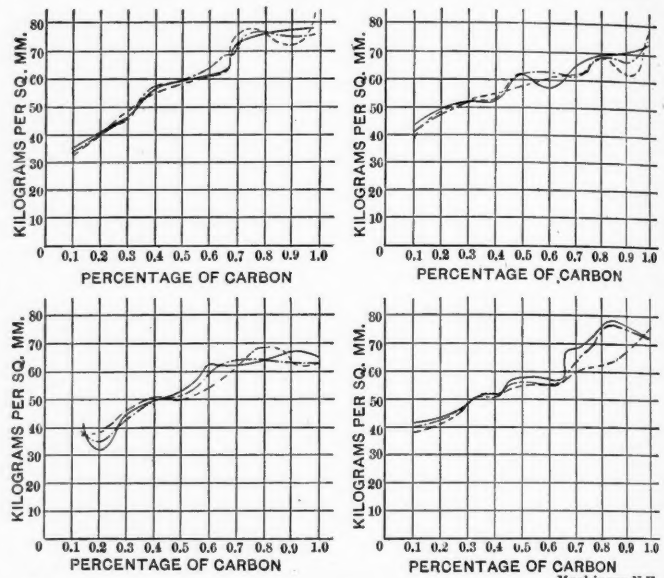
It may be of interest to add here the views of those not favorably impressed with superheating. They suggest that many practical engine builders object to superheat exceeding 150 degrees F., as valves and cylinders are apt to become scored. It is true that by adopting drop valves, instead of Corliss or slide valves, the troubles can be reduced, though not entirely avoided, but there are objections to the change. The new valves and valve gear necessitate new designs and patterns, and in addition bring along special operating troubles of their own. Most turbines have a natural advantage over the reciprocating engine so far as the use of superheated steam is concerned, because they have no bearing or rubbing surfaces under pressure exposed to the action of the superheated steam. On the other hand, the fine clearances, which are so desirable in the working parts, are more influenced and altered by superheated steam. This is especially the case in reaction turbines. In blades of certain nickel alloys, highly superheated steam has been found to produce brittleness.

As regards the economy of superheated steam, it is usually taken for granted that it effects a substantial one. Information, the opponents claim, on this point is limited, owing in part to a tendency of comparatively recent growth for engineers to speak of the performance of an engine in terms of the weight of steam consumed per horse-power. It is not so long since it was usual to estimate the performance in terms of the coal consumption at the boiler. This, of course, by introducing the unknown efficiency of the boiler as a factor, rendered comparisons of engine efficiencies a very difficult and uncertain matter. This was recognized, and in order to eliminate the boiler from the comparison, the weight of steam consumed is now generally the basis of comparison. But superheated steam contains more heat than saturated steam, and assuming that the boiler efficiency remains unaltered, it is clear that the weights of saturated and superheated steam used by the same engine are not directly of use for comparing the efficiencies in the two cases. Thus, tests show that a good steam engine or turbine will have its steam consumption reduced by about 1.7 pound of steam per kilowatt hour, or from 8 to 10 per cent of the normal steam consumption, for every 100 degrees F. of superheat. Taking the higher figure so as to allow everything possible to the superheated steam, it must be pointed out that these figures do not signify that the coal consumption is reduced by 10 per cent. With independently fired superheaters, the coal consumption is probably no less than with saturated steam. With ordinary fine or integral superheaters the effect on the coal consumption depends upon whether or not an economizer is fitted, and the position of the superheater, whether directly over the fire or in the flue, meeting the gases after leaving the boiler proper. Superheaters are most economical when there is no economizer, and in that case should never meet the hot gases before they reach the boiler heating surface.

If it be assumed that the over-all efficiency of the boiler is not affected by the superheater, then the extra heat in a given weight of steam as compared with saturated steam is about 5 per cent for 100 degrees of superheat. The decrease in the steam consumption being 10 per cent, the net economy of fuel is 5 per cent, or, say, from 0.07 to 0.1 pounds of coal per indicated horse-power hour for the main engine. The question is whether or not this saving in fuel pays for the means employed to obtain it. With a 1,000-horse-power engine for one year, the charges on the superheater for interest, depreciation and maintenance at 12½ per cent would be about £35. For each 1 per cent of the engine's maximum yearly output (continuous running day and night at full load), the saving in fuel would be from three to four tons. From this, the saving can be estimated under any given conditions of working, and for any given price of fuel. For instance, consider a mill or factory in which the engine output is 35 per cent of the maximum, coal costing 6 shillings a ton, delivered. The coal is usually slack; the greater saving in weight of four tons per 1 per cent, or 140 tons per year may, therefore, be taken. This gives a reduction in the coal bill of £42, or a saving over the fixed charges of £7 per year; with dearer coal a larger saving would result.

THE BRINELL METHOD OF TESTING THE HARDNESS OF METALS.

The method of testing the hardness of metals devised by Mr. J. A. Brinell has received very favorable attention from metallurgists in this, as well as in other countries. In 1900 Mr. Brinell, then chief engineer and technical manager of the Fagersta Iron and Steel Works in Sweden, first made public his method of testing the hardness of iron and steel, by submitting it to the Society of Swedish Engineers in Stockholm. At the meeting of the *Congrès International des Méthodes d'Essai des Matériaux de Construction* in Paris the same year the method attracted general attention, and its merits were duly acknowledged by awarding the inventor with a personal *Grand Prix* at the Paris Exposition. The method was first described in the English language by Mr. Axel Wahlberg in a paper before the Iron and Steel Institute in 1901. Since then, the practical value of this method has been amply substantiated on various occasions by means of comprehensive tests and investigations undertaken by several distinguished scientists in different countries. In working out his method,



Machinery,N.Y.

Fig. 1. Diagrams showing Relation between Results Obtained by Various Methods for ascertaining the Ultimate Strength of Materials.

Brinell kept in view the necessity of taking into account the requirements that the method must be trustworthy, must be easy to learn and apply, and capable of being used on almost any piece of metal, and particularly, to be used on metal without in any way being destructive to the sample.

Principle of Method for Testing Hardness of Metals.

The Brinell method consists in partly forcing a hardened steel ball into the sample to be tested so as to effect a slight spherical impression, the dimensions of which will then serve as a basis for ascertaining the hardness of the metal. The diameter of the impression is measured, and the spherical area of the concavity calculated. On dividing the amount of pressure required in kilogrammes for effecting the impression by the area of the impression in square millimeters an expression for the hardness of the material tested is obtained, this expression or number being called the *hardness numeral.* In order to render the results thus obtained by different tests directly comparable with one another, there has been adopted a common standard as well with regard to the size of ball as to the amount of loading. The standard diameter of the ball is 10 millimeters (0.3937 inch) and the pressure 3,000 kilogrammes (6,614 pounds) in the case of iron and steel, while in the case of softer metals a pressure of 500 kilogrammes (1,102 pounds) is used. Any variation either in the size of the ball or the amount of loading will be apt to occasion more or less confusion without there being any advantage to compensate for such inconvenience. Besides, making any comparisons between results thus obtained in a different manner would be more or less troublesome, and complicated calculations would be required.

The diameter of the impression is measured by means of a microscope of suitable construction, and the hardness numeral

may be obtained without calculation directly from the table given herewith, worked out for the standard diameter of ball and pressures mentioned. The formulas employed in the calculation of this table are as follows:

$$y = 2\pi r\,(r - \sqrt{r^2 - R^2}) \qquad (1)$$

$$H = \frac{K}{y} \qquad (2)$$

in which formulas

r = radius of ball in millimeters,
R = radius of depression in millimeters,
y = superficial area of depression in square millimeters,
K = pressure on ball in kilogrammes,
H = hardness numeral.

Suppose, for instance, that the radius of the ball equals 5 millimeters (0.1968 inch), and that the test is undertaken on a piece of steel, the pressure consequently applied being 3,000 kilogrammes (6,614 pounds). Assuming that we found the diameter of the depression equal to 2 millimeters (0.7874 inch) by measurement, we have:

$$2\ \pi \times 5\ (5 - \sqrt{25 - 4}) = 13.13 = y,$$

and

$$\frac{3{,}000}{13.13} = 228 = H,$$

which as we see agrees with the figure given in our table for a 4 millimeters diameter of impression.

If the hardness numerals are multiplied by these coefficients, the result obtained will be the ultimate tensile strength of the material in kilogrammes per square millimeter. It is evident that coefficients can easily be worked out so that if the hardness numerals be multiplied by these the strength could be obtained in pounds per square inch. Suppose, for instance, that a test of an annealed steel bar by means of the Brinell ball test gave an impression of a diameter of 4.6 millimeters. Then the hardness numeral, according to our table, would be 170, and the ultimate tensile strength consequently $0.362 \times 170 = 61.5$ kilogrammes per square millimeter, provided the impression was effected transversely to the rolling direction.

In Fig. 1 are shown a number of diagrams which indicate the results obtained at the tests undertaken to ascertain the coefficients given. In these diagrams the full heavy line indicates the tensile strength of the material, as calculated from the ball tests in the rolling direction. The dotted lines indicate the strength as calculated from the ball tests in a transversal direction, and the "dash-dotted" lines show the actual tensile strength of the material as ascertained by ordinary methods for ascertaining this value. It is interesting to note how closely the three curves agree with one another, and considering the general uncertainty and variation met with when testing the same kind of material for tensile strength by the ordinary methods, it is safe to say that the ball test method comes nearly as close to the actual results as does any other method used. Especially within the range of the lower rates of carbon, or up to 0.5 per cent, or in other words, within the range of all ordinary construction materials, the coincidents are, in fact, so very nearly perfect as to be amply sufficient to satisfy all practical requirements.

TABLE OF HARDNESS NUMERALS.
Steel ball of 10 millimeters diameter.

Diameter of Impression, mm.	Hardness Numeral. Pressure, kg.		Diameter of Impression, mm.	Hardness Numeral. Pressure, kg.		Diameter of Impression, mm.	Hardness Numeral. Pressure, kg.		Diameter of Impression, mm.	Hardness Numeral. Pressure, kg.		Diameter of Impression, mm.	Hardness Numeral. Pressure, kg.	
	3000	500		3000	500		3000	500		3000	500		3000	500
2.00	946	158	3.00	418	70	4.00	228	38	5.00	143	23.8	6.00	95	15.9
2.05	898	150	3.05	402	67	4.05	223	37	5.05	140	23.3	6.05	94	15.6
2.10	857	143	3.10	387	65	4.10	217	36	5.10	137	22.8	6.10	92	15.3
2.15	817	136	3.15	375	63	4.15	212	35	5.15	134	22.3	6.15	90	15.1
2.20	782	130	3.20	364	61	4.20	207	34.5	5.20	131	21.8	6.20	89	14.8
2.25	744	124	3.25	351	59	4.25	202	33.6	5.25	128	21.5	6.25	87	14.5
2.30	713	119	3.30	340	57	4.30	196	32.6	5.30	126	21	6.30	86	14.3
2.35	683	114	3.35	332	55	4.35	192	32	5.35	124	20.6	6.35	84	14
2.40	652	109	3.40	321	54	4.40	187	31.2	5.40	121	20.1	6.40	82	13.8
2.45	627	105	3.45	311	52	4.45	183	30.4	5.45	118	19.7	6.45	81	13.5
2.50	600	100	3.50	302	50	4.50	179	29.7	5.50	116	19.3	6.50	80	13.3
2.55	578	96	3.55	293	49	4.55	174	29.1	5.55	114	19	6.55	79	13.1
2 60	555	93	3.60	286	48	4.60	170	28.4	5 60	112	18.6	6.60	77	12.8
2.65	532	89	3.65	277	46	4.65	166	27.8	5.65	109	18.2	6.65	76	12.6
2.70	512	86	3.70	269	45	4.70	163	27.2	5.70	107	17.8	6.70	74	12.4
2.75	495	83	3.75	262	44	4.75	159	26.5	5.75	105	17.5	6.75	73	12.2
2.80	477	80	3.80	255	43	4.80	156	25.9	5.80	103	17.2	6.80	71.5	11.9
2.85	460	77	3.85	248	41	4.85	153	25.4	5.85	101	16 9	6.85	70	11.7
2.90	444	74	3.90	241	40	4.90	149	24.9	5.90	99	16.6	6.90	69	11.5
2.95	430	73	3.95	235	39	4.95	146	24.4	5.95	97	16.2	6.95	68	11.3

Relation between Hardness of Materials and Ultimate Strength.

It has been pointed out by Mr. Brinell himself that this method of testing hardness of metals offers a most ready and convenient means of ascertaining within close limits the ultimate strength of iron and steel. This, in fact, is one of the most interesting and important results of this method of measuring hardness. In order to determine the ultimate strength of iron and steel, it is only necessary to establish a constant coefficient determined by experiments which serves as a factor by which the hardness numerals are multiplied, the product being the ultimate strength. Rather comprehensive experiments were undertaken with a considerable number of specimens of annealed material obtained from various steel works for the purpose of establishing the coefficient by the present director of the Office for Testing Materials of the Royal Technical Institution at Stockholm. The results obtained were as follows:

For hardness numerals below 175, when the impression is effected transversely to the rolling direction, the coefficient equals 0.362; when the impression is effected in the rolling direction, the coefficient equals 0.354.

For hardness numerals above 175, when the impression is effected transversely to the rolling direction, the coefficient equals 0.344; when the impression is effected in the rolling direction, the coefficient equals 0.324.

In the case of any steel, whether it be annealed or not, that has been submitted to some further treatment of any other kind than annealing, such as cold working, etc., or in the case of any special steel, there would be other coefficients needed which would then also be ascertained by experiments. The same coefficient, however, will hold true for the same kind of material having been subjected to the same treatment. Thus, the ball testing method for strength is equally satisfactory, and far more convenient, in all cases where the rupture test would be applied. One of the greatest advantages of the Brinell method is that in the case of a large number of objects being required to be tested, each one of the objects can be tested without demolition, and without the trouble of preparing test bars.

Application of the Brinell Ball Test Method.

Summarizing what has been said in the previous discussion, and adding some other important points, we may state the various uses for which the Brinell ball test method may

be applied, outside of the direct test of the hardness of constructing materials and the calculation from this test of the ultimate strength of the materials, as follows:

1. Determining the carbon content in iron and steel.
2. Examining various manufactured goods and objects, such as rails, tires, projectiles, armor plates, guns, gun barrels, structural materials, etc., without damage to the object tested.
3. Ascertaining the quality of the material in finished pieces and fragments of machinery even in such cases when no specimen bars are obtainable for undertaking ordinary tensile tests.

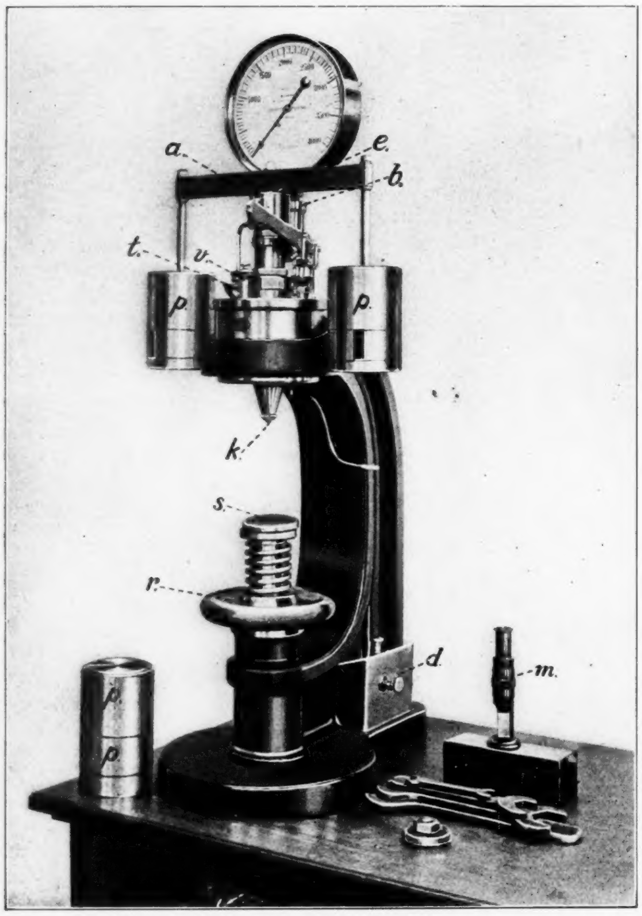


Fig. 2. Aktiebolaget Alpha's Machine for Testing Hardness of Materials.

4. Ascertaining the effects of annealing and hardening of steel.
5. Ascertaining the homogeneity of hardening in any manufactured articles of hardened steel.
6. Ascertaining the hardening power of various quenching liquids, and the influence of temperature of such liquids on the hardening results.
7. Ascertaining the effect of cold working on various materials.

Machines used for Testing the Hardness of Metals by the Brinell Method.

The method of applying the Brinell ball test was at first only possible in such establishments where a tensile testing machine was installed. As these machines are rather expensive, the use of the ball test method was limited. For this reason a Swedish firm, Aktiebolaget Alpha, Stockholm, Sweden, has designed and placed on the market a compact machine specially intended for making hardness tests. This machine, as shown in Fig. 2, consists of a hydraulic press acting downward, the lower part of the piston being fitted with a 10-millimeter steel ball *k* by means of which the impression is to be effected in the surface of the specimen or object to be tested. This object is placed on the support *s* which is vertically adjustable by means of the hand-wheel *r*, while at the same time it can be inclined sideways when this is needed on account of the irregular shape of the part tested. The whole apparatus is solidly mounted on a cast iron stand. The pressure is effected by means of a small hand pump, and the amount of pressure can be read off directly in kilogrammes on the pressure gage mounted at the top of the machine.

In order to insure against any eventual non-working of the manometer, this machine is fitted with a special contrivance purporting to control in a most infallible manner the indications of that apparatus, while at the same time serving to prevent any excess of pressure beyond the exact amount needed according to the case. This controlling apparatus consists of a smaller cylinder, *a*, directly communicating with the press-cylinder. On being loaded with weights corresponding to the amount of pressure required, the piston in this cylinder will be pushed upward by the pressure effected within the press-cylinder at the very moment when the requisite testing pressure is attained. Owing to this additional device, there can thus be no question whatever of any mistake or any errors as to the testing results, that might eventually be due to the manometer getting out of order.

Method of Performing the Ball Test.

The test specimen must be perfectly plane on the very spot where the impression is to be made. It is then placed on the support *s*, Fig. 2, which, as mentioned, is adjusted by means of the hand-wheel *r* so as to come into contact with the ball *k*. A few slow strokes of the hand pump will then cause the pressure needed to force the ball downward, and a slight impression will be obtained in the object tested, but as soon as the requisite amount of pressure has been attained, the upper piston is pushed with the controlling apparatus upward, as previously described. On testing specimens of iron and steel, the pressure is maintained on the specimen for 15 seconds, but in the case of softer materials for at least half a minute. After the elapse of this time, the pressure is released, and the contact between the ball and the sample will cease. A spiral spring fitted within the cylinder, and being just of sufficient strength to overcome the weight of the press piston, pulls the same upward into its former position, while forcing the liquid back into its cistern. The diameter of the impression effected by the ball is then measured by the microscope *m*, which is specially constructed for this purpose, the results obtained by this measurement being exact within 0.05 millimeter (0.002 inch). Fig. 3 shows a cross-section through the cylinder and piston part of the machine. Another type of machine is designed for special tests in which very high pressures are required. The ball in this machine is 19 millimeters (0.748 inch) in diameter, and the pressures employed vary from 3 to 50 tons. The construction and operation are otherwise exactly the same as that of the smaller machine in Fig. 2.

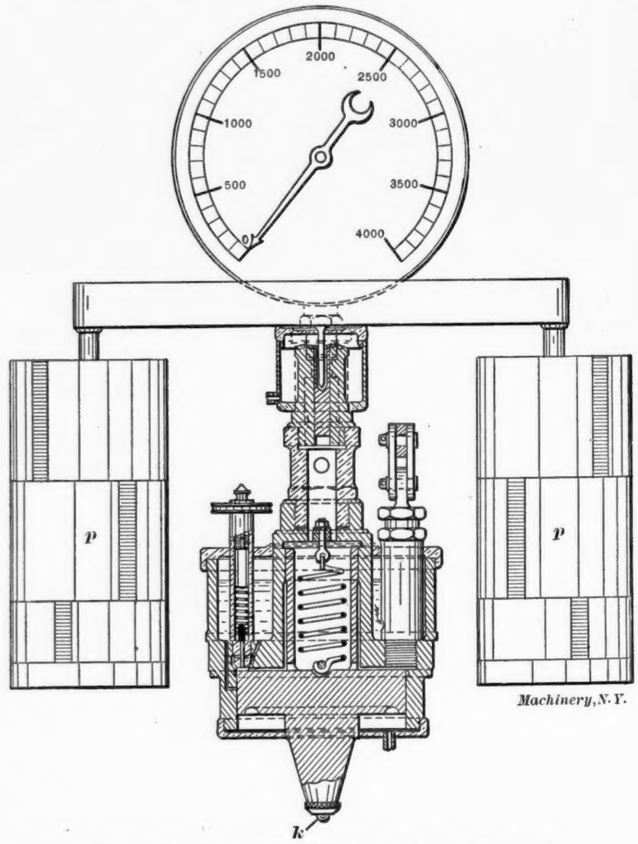


Fig. 3. Section of Press Cylinder of Machine in Fig. 2.

DROP FORGE WORK IN AN AUTOMOBILE SHOP.*

ETHAN VIALL.†

Ethan Viall.‡

Very little of value has been written on drop forging die work and shop practice as it actually exists in the modern drop forging shop. Here and there, a solitary die or device has been pictured and described, or a few sketches made of dies that may be entirely imaginary, so far as can be learned from any evidence offered, and which are of such a simple and elementary nature as to convey no adequate idea whatever of the magnitude or difficulty of the work, to anyone not familiar with it. This class of contributions covers the greater part of what has been published on a practice that has grown and developed from the hand forging process of the hammer and anvil, to one of the most important branches of modern machine industry.

Hundreds of parts that were formerly cast from malleable iron are now drop forged, the extra cost being more than made up by the uniformity, strength and reliability of the product; and no one has been quicker to realize this than the really live, up-to-date automobile manufacturer to whom the mechanical world is indebted for so many other valuable mechanical developments.

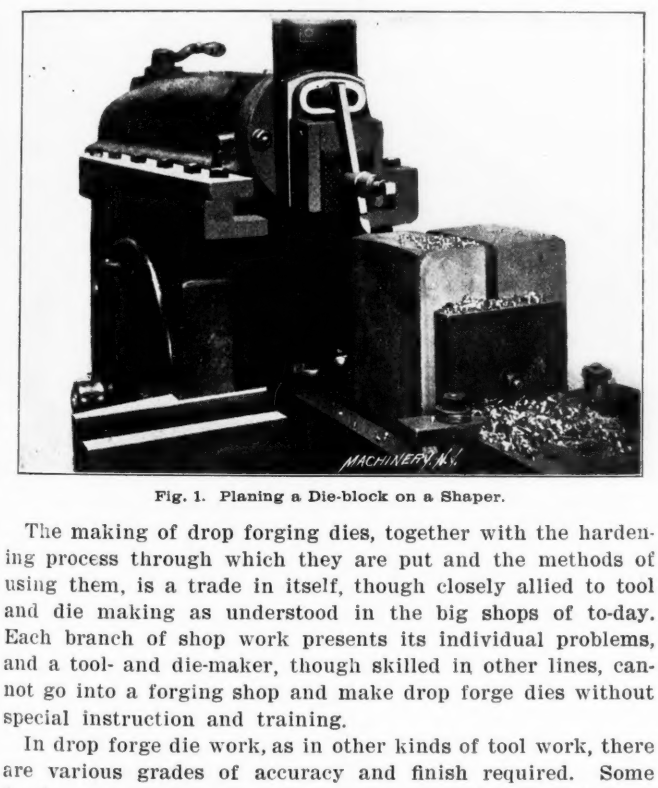


Fig. 1. Planing a Die-block on a Shaper.

The making of drop forging dies, together with the hardening process through which they are put and the methods of using them, is a trade in itself, though closely allied to tool and die making as understood in the big shops of to-day. Each branch of shop work presents its individual problems, and a tool- and die-maker, though skilled in other lines, cannot go into a forging shop and make drop forge dies without special instruction and training.

In drop forge die work, as in other kinds of tool work, there are various grades of accuracy and finish required. Some forgings must come from the hammer practically finished to size, while others are made large enough to allow considerable machining. Where only a few pieces of a rough nature are required, little skill is needed in the making or maintenance of the dies, but where small accurate parts are to be made in large quantities, special tools for both hand and machine use, and trained, skillful diemakers are needed, as well as a careful selection of the steel used.

Materials for, and Life of, Drop Forging Dies.

Steel, cast into blocks, is not suitable for this work, as flaws or blowholes are likely to develop where least expected or desired, so as a general rule, forged blocks of open hearth crucible steel are used. These blocks are either purchased ready forged, in various sizes, from the steel manufacturers, or are forged in the shop where they are used, the former plan being the usual one.

A rough estimate as to the average life of a drop forging die, used for medium sized work on Bessemer steel, was given by a foreman of long experience, as about forty thousand pieces. Some dies might be broken immediately when put in operation, while others might stand for a hundred thousand pieces or even more.

Automobile Shop Drop Forging Practice.

In preparing this article, the photographs and data were obtained in the factory of Thomas B. Jeffery & Co., Kenosha, Wisconsin, the manufacturers of the famous "Rambler" automobile. This company's drop forging department is far ahead of anything outside of the big concerns that make a specialty of drop forgings, and consists of a well-lighted, finely-equipped tool-room, used only for drop forge die work, a thoroughly up-to-date hardening plant, and a big building full of steam hammers, punch presses, heating furnaces and every appliance necessary for first-class work. This department is under the direct supervision of one of the best all-round drop forge men in the West.

The greater part of the drop forgings made here are of Bessemer bar steel, though some of the more particular automobile fittings are made of special grades of tool steel. All of the drop forging dies are of the highest class, calling for the best die-making skill, and necessitating a great deal of hand work in addition to the most accurate machining.

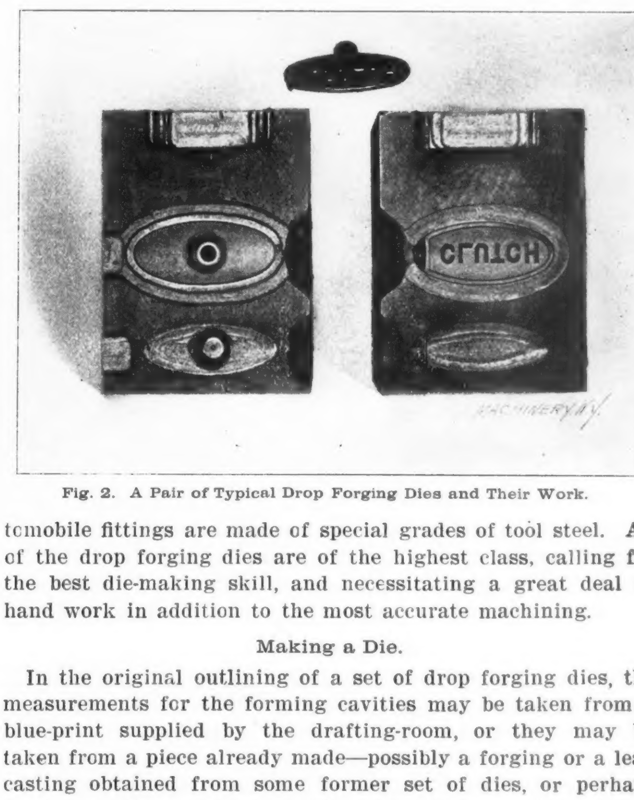


Fig. 2. A Pair of Typical Drop Forging Dies and Their Work.

Making a Die.

In the original outlining of a set of drop forging dies, the measurements for the forming cavities may be taken from a blue-print supplied by the drafting-room, or they may be taken from a piece already made—possibly a forging or a lead casting obtained from some former set of dies, or perhaps a piece made up for a model. Sometimes a sheet metal templet is made to assist in obtaining the desired shape of the die cavities, while in other cases, only the outline scribed on the coppered surface, together with the necessary measurements, is needed. The size and outline of the forging to be made, as well as the accuracy required, govern the method of procedure.

The die blocks, which, as already stated, are forged of open hearth crucible steel, are first placed in a shaper and carefully surfaced off to the required dimensions, as shown in Fig. 1. These blocks are made over-size, so that enough of the surface can be machined off to insure good, sound metal to work on. The outlines for the breaking-down or roughing, the finishing, and sometimes the bending forms are then laid

* For previous articles on drop forging, see "Drop and Stamped Forgings," by Joseph Horner, May, 1908, and the previous articles there referred to.

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off on the coppered faces, and the cavities roughed out on the drill press or lathe as the case may require, or on the profiling machine, as shown in Fig. 3.

The same set of dies shown in this engraving is shown still further roughed out in Fig. 2. The shape of the forging to be made in this set is shown at the top of the illustration, and it is a foot pedal for a clutch lever. The channel for the fin, or "flash," which is formed in the finishing operation, is plainly shown in the middle cavities.

The letters, C L U T C H, were first lightly stamped on the metal with special steel letters to get the outline; then they were chiseled out, and finally finished by driving in the steel letters to smooth up the roughness caused by chiseling.

Fig. 4 shows the final cuts being taken on the breaking-down part of this die, the rest of the work consisting of scraping, gouging and chiseling.

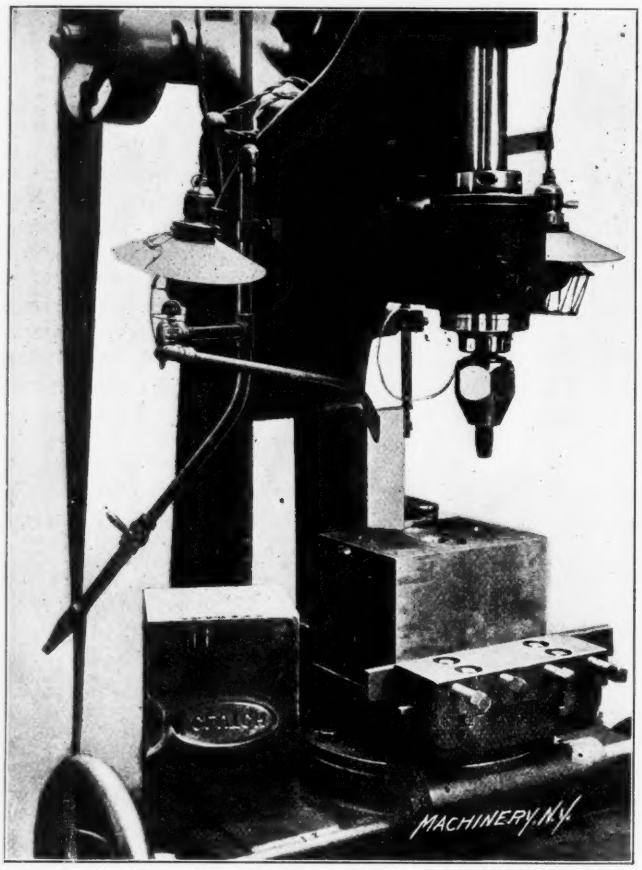

Fig. 3. Profiling Machine much Used in Die-sinking.

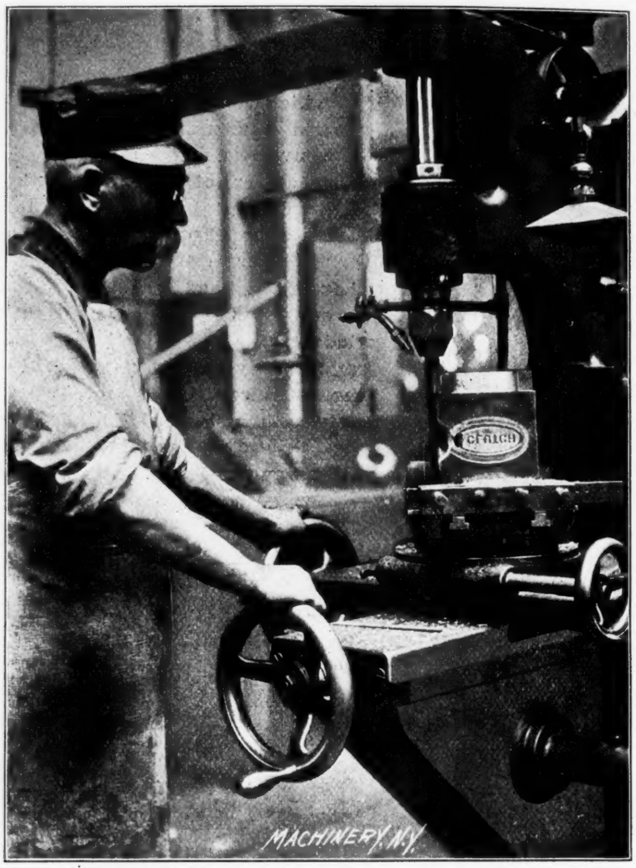

Fig. 4. Finishing the Die shown in Fig. 2 on the Profiling Machine.

Fig. 5. Special "Ball Vise" used in Sinking Drop Forging Dies.

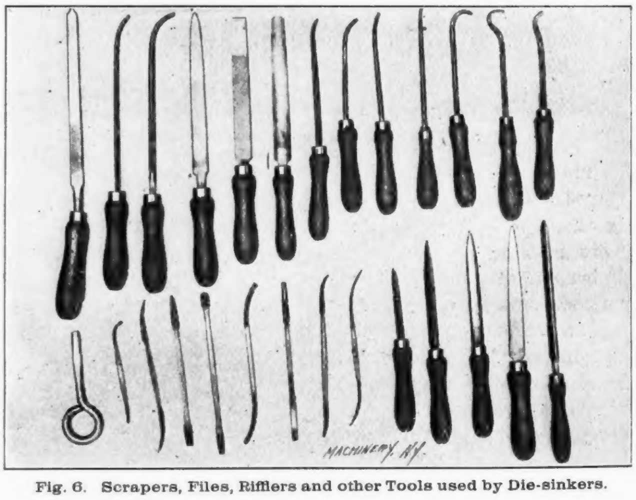

Fig. 6. Scrapers, Files, Rifflers and other Tools used by Die-sinkers.

Tools Employed in Making Dies.

For the hand work, the die block is held in a special "ball vise" which is shown in Fig. 5. A vise of this type is the handiest device imaginable for heavy die work. This illustration also shows the breaking-down part of the die a little more plainly than the previous examples.

Fig. 6 shows a few of the tools, scrapers, and rifflers used in the finishing work. These are mostly made of old files and are ground or bent to suit the needs of particular cases.

In Fig. 7 are some of the milling tools that have been made especially for this work. Only twenty-four of them are shown, though several hundred of all shapes and sizes are in stock. Another set of special cutters is shown in Fig. 8. Two of these have a single inserted blade or "fly-cutter" held in place by a set-screw, and are very useful tools for some kinds of work.

The tools shown in Fig. 9 are known as "types," and are used in scraping out cylindrical cavities to size. These types are turned to the proper size, and when used are smeared with lead and rocked back and forth in the partly finished cavity. The metal is then scraped away wherever the lead shows. For cylindrical work, these types are indispensable tools.

The tools shown in Fig. 10 were made by one of the expert die sinkers in the Jeffery shop. The tool shown at the right is used to scribe an outline from a forging. It consists of a hardened steel blade, with a point on one end, set into a flat steel block in such a way that it is free to move up and down to a limited extent. The rivet shown on the side passes

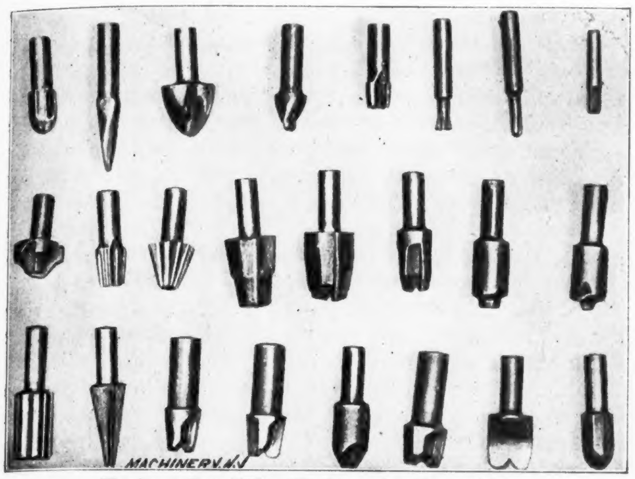

Fig. 7. A Few Milling Tools used in Die-sinking.

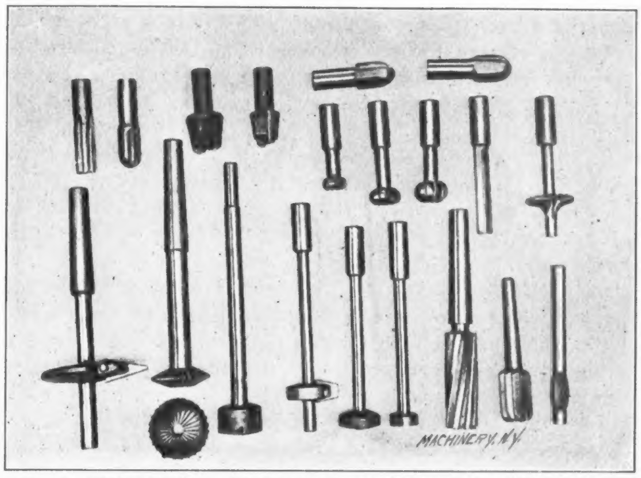

Fig. 8. Milling Tools used in Die-sinking, with Examples of Fly Cutters.

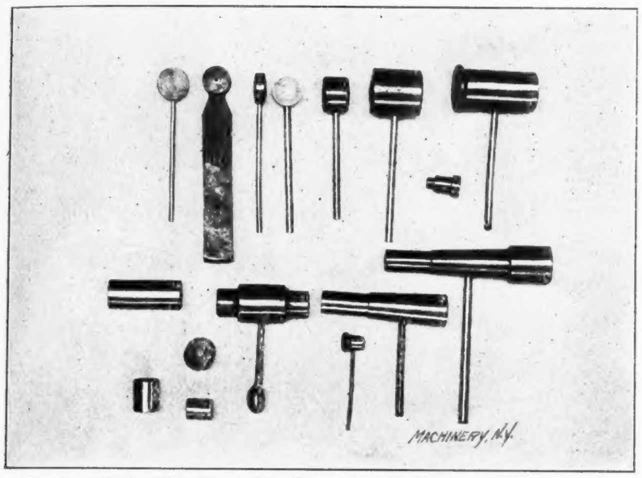

Fig. 9. "Typing" Tools used by Die-sinkers to Form Circular Cavities.

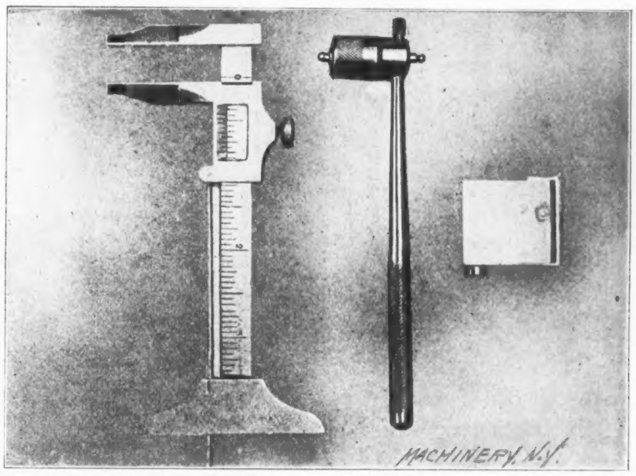

Fig. 10. Vernier Caliper Depth Gage, Inside Micrometer, and Scribing Block.


Fig. 11. Samples of Lead Castings or Proofs taken from Drop Forging Dies for Testing the Accuracy of Outline.

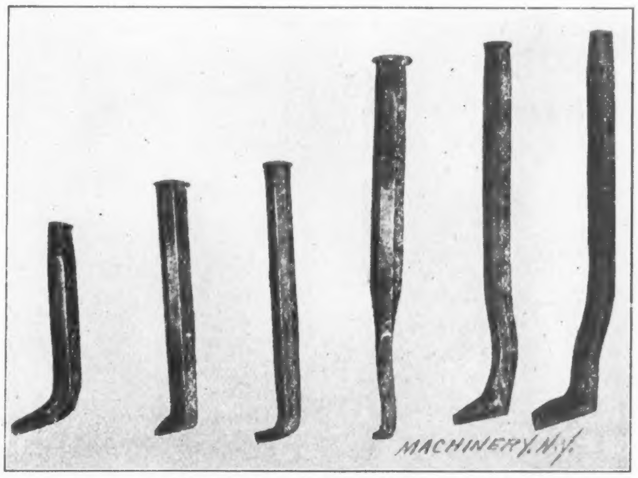

Fig. 12. Staking Tools used to Repair Worn and Cracked Drop Forging Dies

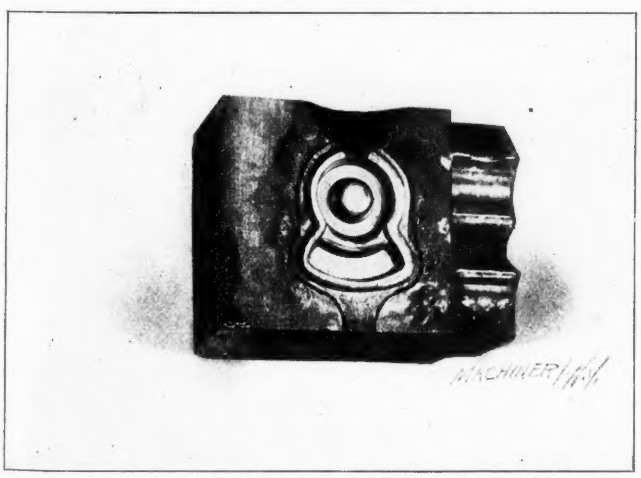

Fig. 13. An Example of Drop Forging Die showing Breaking-down Die at the Right.

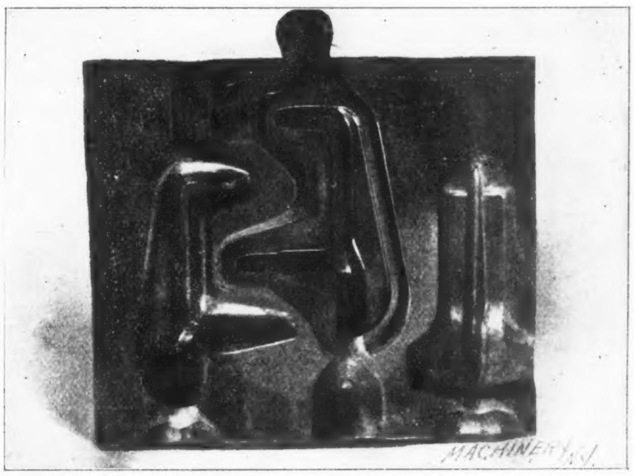

Fig. 14. Drop Forging Die showing both Edging and Flatting Breaking-down Dies.

through a short slot in the blade. When in use, a flat spring on the top edge of the tool presses the point down onto the coppered surface, causing a mark wherever moved. To use this tool, it is held on edge with the point down and the edge of the hardened blade in contact with the forging. The steel block keeps the blade perpendicular, and by keeping the edge of the blade in contact with the forging while scribing, a correct outline is obtained, which could not be done with an ordinary scriber on account of the working outline being considerably above the die face.

The middle tool shown in Fig. 10 is a one-inch inside micrometer, which was made by the die-sinker because he could not buy one small enough for the purpose. The other tool is a regular stock caliper square, to which has been added a depth gage. The gage is so made that the rod projects the same distance that the caliper jaws are apart. The usefulness and convenience of this tool are at once apparent to a toolmaker.

Examples of Drop Forging Dies.

One-half of a die set, showing the breaking-down and finishing forms, is illustrated in Fig. 13. In this illustration the method of leaving a ridge around the finishing form and cutting a channel for the fin is very plainly shown. This method is followed in all of the drop forge dies made in the Jeffery shop. Fig. 14 shows a more complicated die. In this, both edging and flatting breaking-down die forms are shown. In using this die, the hot bar from which the forging is being made, is alternately swung from one to the other form, it being held edgewise in one and flat in the other, and given a blow or two until sufficiently reduced for the finishing form, after which it is cut off from the bar by a shear fastened to the hammer at one side of the die block.

In Fig. 15 the roughing or breaking-down die is shown and also a bending form, the bar being roughed into shape, and then bent and finished. Of course, in these last two illustrations it is understood that the cuts show only one-half

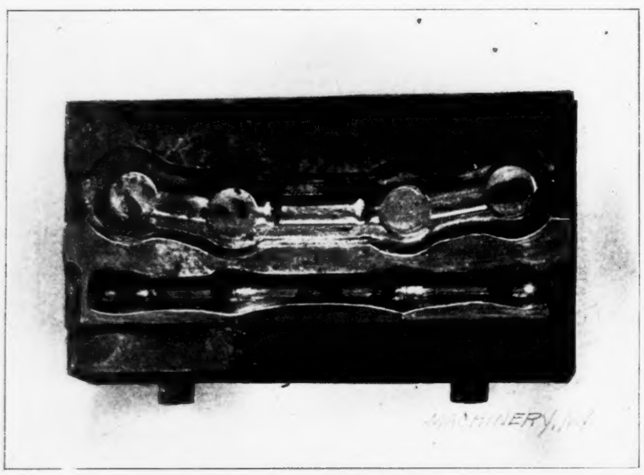

Fig. 15. Drop Forging Die showing Bending Form in Front.

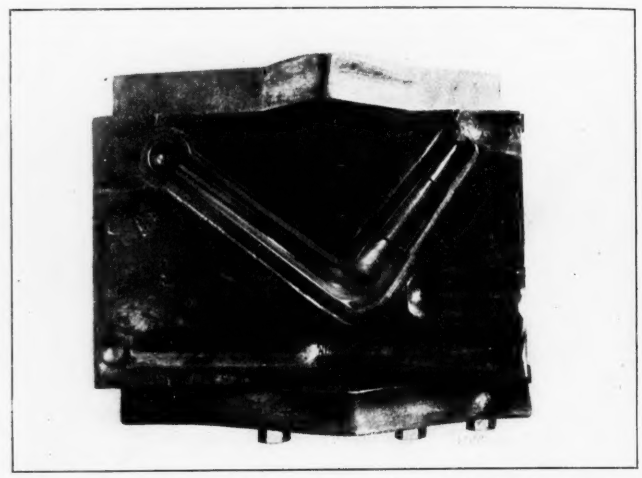

Fig. 16. Drop Forging Die and Bending Die for Steering Gear Part.

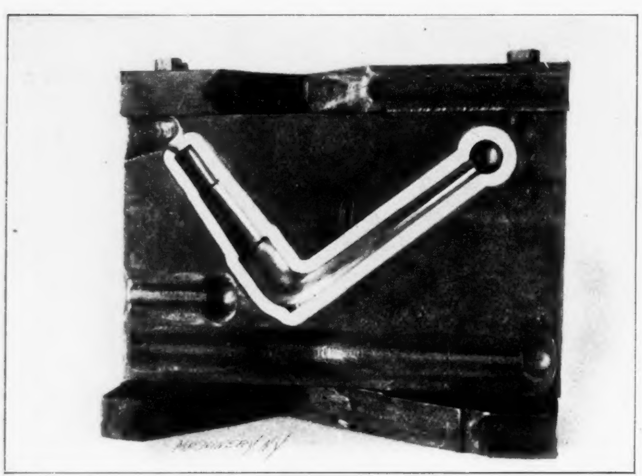

Fig. 17. Mating Die to Die in Fig. 16.

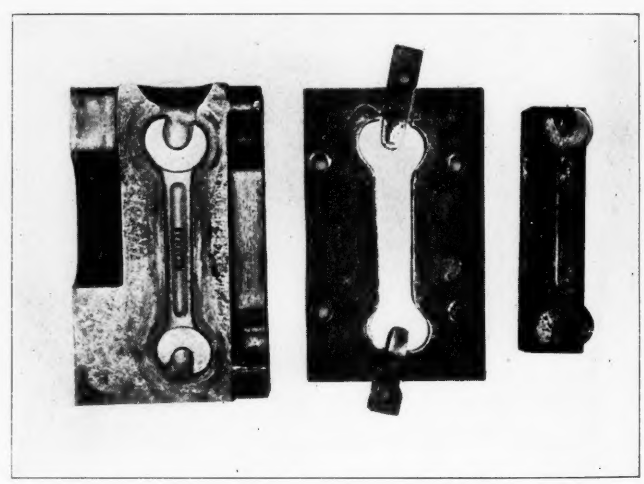

Fig. 18. Drop Forging Die for Wrench and Trimming Die for Same.

The Lead Casting or Proof.

After the mechanical work on a set of dies is done, a lead casting of the cavity is made and sent to the superintendent to be passed upon. If it is correct, the dies are hardened and sent to the forging shop, but if it is off size or shape, or for any reason not satisfactory, suitable changes are made, and another lead impression taken and passed upon as before. Fig. 11 shows a number of these lead castings which are kept in the tool-room for reference, and they often save considerable trouble when making duplicate dies.

Staking Tools used for Repairing Dies.

After a set of dies has been in use for some time, the dies are likely to develop cracks or drawing seams which cause ridges and rough spots on the forgings. These cracks are closed up by hammering first on one side and then on the other with a hammer and what are called "staking" tools, which are simply special shaped, tempered steel punches made of chisel steel stock. Some of these staking tools are shown in Fig. 12.

of the set, the other half corresponding in shape to the one shown in such a way as to produce the desired shape. To better illustrate this for the benefit of those not familiar with this class of work, both halves of a set of dies are shown in Figs. 16 and 17. These show the complete forging and bending parts for this particular piece. The end of the finishing form also shows a place where one of the types illustrated in Fig. 9 was used when first working out the cavity.

Trimming Dies.

Some of the forgings are of such shape that the fin or flash formed is easily ground or machined off, while others are put through a trimming die. These trimming dies are about the same as the trimming dies used for other classes of work, and so need little comment. Fig. 18 shows a set of forging and trimming dies used for making "Rambler" wrenches. The breaking-down form is very plainly shown, as is also the finishing cavity. The trimming punch is at one side, while the trimming die in the middle is shown made up

of four separate parts. This is done because the die parts that shear out the wrench slots wear or break sooner than the rest of the die, and when made this way they are easily replaced without necessitating a wholly new die, which would be the case if made solid.

Fig. 19 shows a number of dies on the storage shelves, only one-half of each set being shown, the other half of each set being back of the one visible. The trimming dies which are in constant use are kept conveniently near the presses in the forge room. Both the trimming and forging dies are stored on heavy shelves close to where they are used, thus saving the unnecessary "toting" that is practiced in so many shops.

The keynote of the whole Jeffery factory is: "System without red tape," and the result is visible everywhere to the practiced observer, though a casual visitor would wonder how material traveled through as smoothly as it does.

Heating Furnaces.

The heating furnaces in a forging shop must be set near the hammers, and Fig. 20 shows how the oil furnaces are

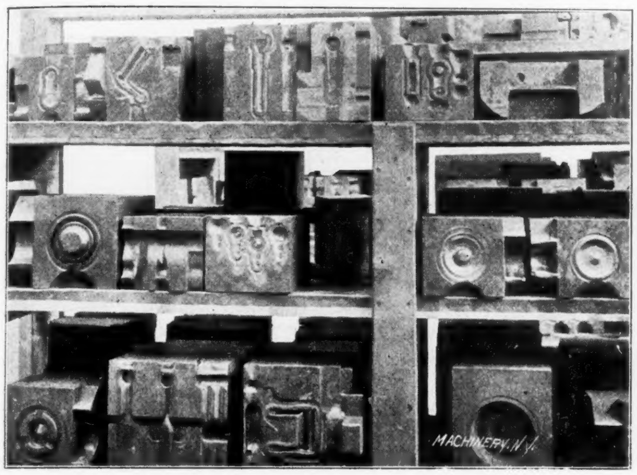

Fig. 19. A Few Examples of Drop Forging Dies in Storage.

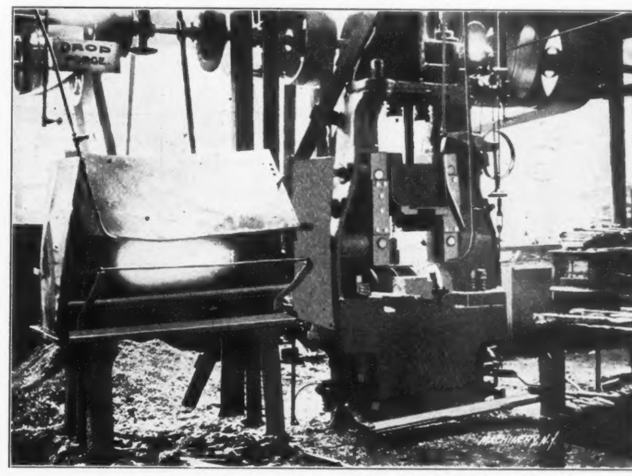

Fig. 20. Oil Heating Furnaces and Drop Hammer.

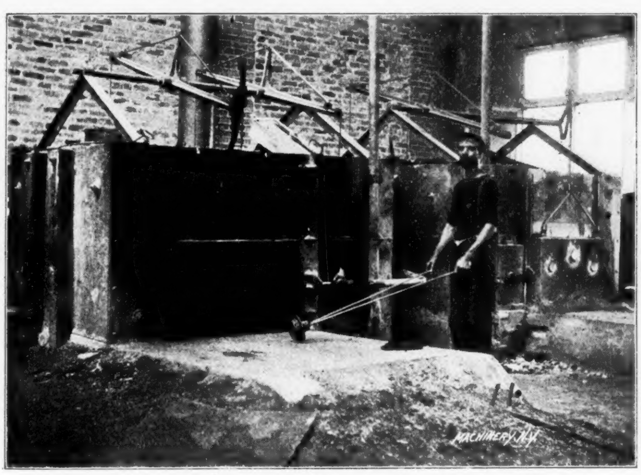

Fig. 21. Brown & Sharpe Heating and Annealing Furnaces.

Fig. 22. Hardening the Face of a Drop Forging Die.

placed, so that little time is lost getting the heated metal to the hammers. Fig. 21 is an illustration of two of the big Brown & Sharpe furnaces in the hardening room. For small work several smaller furnaces are used, but those shown are used for large work, and are said to be the best obtainable.

Hardening Drop Forging Dies.

In hardening drop forge dies only the face is hardened. The die is heated and placed face down in a tank of water on a sort of spider support, and a stream of water pours upward onto it. Fig. 22 shows how this is done. In the illustration a round piercing die is being hardened, so the water appears to be boiling up through the center, which would not be the case were it a solid block like a forging die. Large special shaped tongs make the handling of the heavy steel blocks of the drop forge dies comparatively easy.

* * *

Beware of the man who is going to do things to-morrow.—*The Silent Partner.*

JIGS AND FIXTURES—6.

EINAR MORIN.*

EXAMPLES OF THE DESIGN OF OPEN JIGS.

The present installment will be devoted to explaining and illustrating the application of the principles outlined in the previous issues, to the simplest and most common design of drill jig—the open jig. We will assume that the drill jig is to be designed for a piece of work, as shown in Fig. 61. Consideration must first be given to the size of the piece, to the finish given to the piece previous to the drilling operation, the accuracy required as regards the relation of one hole to the other, and in regard to the surfaces of the piece itself. The number of duplicate pieces to be drilled must also be considered, and, in some cases, the material.

The very simplest kind of drill jig that could be used for the case taken as an example would be the one illustrated in Fig. 62, which simply consists of a flat plate of uniform thickness of the same outline as the piece to be drilled, and provided with holes for guiding the drill. Such a jig would be termed a jig plate. For small pieces, the jig plate would be made of machine steel and case-hardened, or from tool steel and hardened. For larger work, a machine steel plate can also be used, but in order to avoid the difficulties which naturally would arise from hardening a large plate, the holes are simply bored larger than the required size of drill, and are provided with lining bushings to guide the drill, as shown in Fig. 63. It would not be necessary, however, to have the jig plate made out of steel for larger work, as a cast iron plate provided with tool steel or machine steel guiding bushings would answer the purpose just as well, and at the same time be much cheaper, and almost as durable. The thickness of the jig plate varies according to the size of the holes to be drilled and the size of the plate itself.

The holes in the jig in Fig. 62 and in the bushings in the

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jig in Fig. 63, are made the same size as the size of the hole to be drilled in the work, with proper clearance for the cutting tools. If the size and location of the holes to be drilled are not very particular, it is sufficient to simply drill through the work with a full size drill guided by the jig plate, but when a nice, smooth, standard size hole is required, the holes in the work must be reamed. The hole is first spotted by a spotting drill, which is of exactly the same size as the reamer used for finishing, and which fits the hole in the jig plate or bushing nicely. Then a so called reamer drill, which is 0.010 inch, or less, smaller in diameter than the reamer, is put through, leaving only a slight amount of stock for the reamer to remove, thereby obtaining a very satisfactory hole. Sometimes a separate loose bushing is used for each one of these operations, but this is expensive and also unnecessary, as the method described gives equally good results.

By using the rose reaming method very good results will also be obtained. In this case two loose bushings besides the lining bushing will be used. These bushings were described and tabulated in the second installment of this series, appearing in the May issue of MACHINERY. The drill preceding the rose chucking reamer is 1/16 inch under the size of the hole.

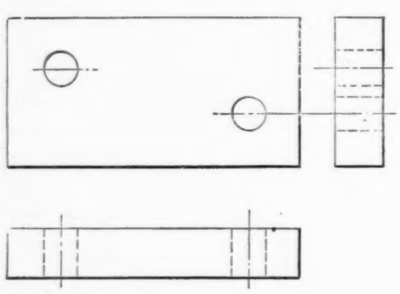


Fig. 61. Sketch of Piece to be Drilled.

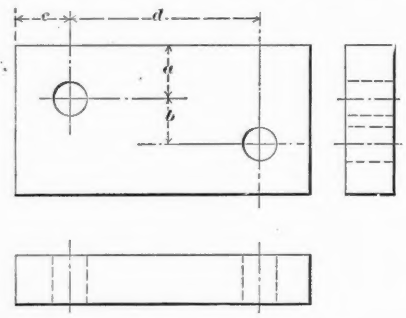


Fig. 62. Simplest Form of Jig for Piece shown in Fig. 61.

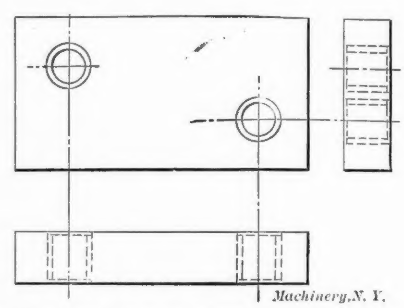


Fig. 63. Plate Jig with Inserted Guide Bushings.

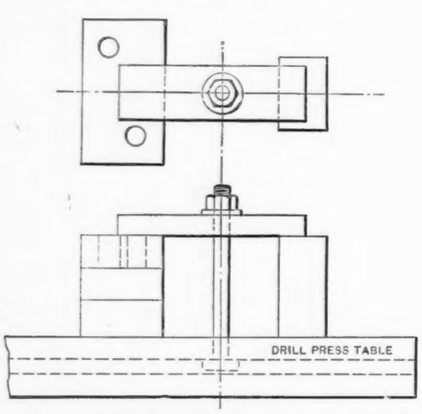


Fig. 64. Holding Jig and Work on Drill Press Table. Two Pieces drilled at Once.

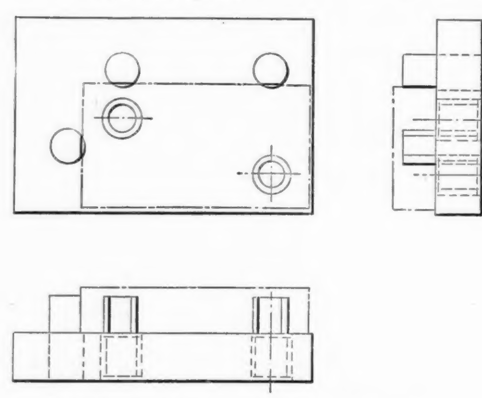


Fig. 65. First Improvement of Plate Jig: Locating Pins Inserted.

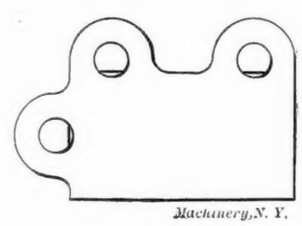


Fig. 66. Variation in Shape of Plate Jig.

This drill is first put through the work, a loose drill bushing made of steel being used for guiding the drill. Then the rose chucking reamer is employed, using, if the hole in the jig be large, a loose bushing made of cast iron.

When dimensioning the jig on the drawing, dimensions should always be given from two finished surfaces of the jig to the center of the holes, or at least to the more important ones. In regard to the holes, it is not sufficient to give only the right angle dimensions, *a*, *b*, *c*, and *d*, etc., Fig. 62, but the radii between the various holes must also be given. If there are more than two holes, the radii should always be given between the nearest holes and also between the holes standing in a certain relation to one another, for instance, between centers of shafts carrying meshing gears, sprockets, etc. This will prove a great help to the tool-maker. In the case under consideration, the dimensions ought to be given from two finished sides of the work to the centers of the holes, and also the dimension between the centers of the holes to be drilled.

When using a simple jig, made as outlined in Figs. 62 and 63, this jig is simply laid down flat on the work and held against it by a C-clamp, a wooden clamp, or, if convenient, held right on the drill press table by means of a strap or clamp, as shown in Fig. 64. Here two pieces of the work are shown beneath the jig plate, both being drilled at one time.

Improving the Simple Form of Jig shown in Fig. 62.

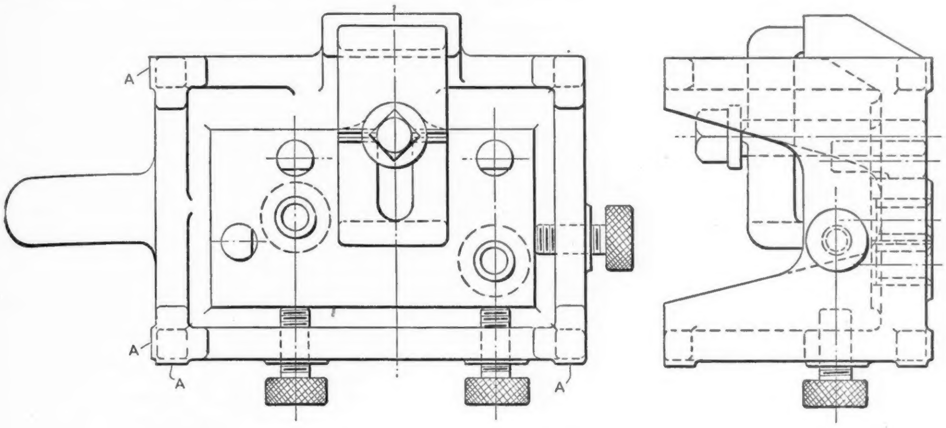
The first improvement that could be made on the jig shown in Fig. 62 would be the placing of locating points in the jig plate in the form of pins, as shown in Fig. 65, in which the dotted lines represent the outline of the work. The plate need not necessarily have the shape shown in Fig. 65, but may have the appearance shown in Fig. 66, according to the conditions. As mentioned in the article last month, exact rules could not be given for the form and shape of jigs, but common sense together with the judgment obtained by long practice must be relied upon in determining the minor points of design.

The adding of the locating points will, of course, increase the cost of the jig somewhat, but the amount of time saved in using the jig will undoubtedly make up for the added expense of the jig, provided a fair number of pieces is to be drilled; besides, a great advantage is gained in that the holes can always be placed in the same relation to the two sides resting against the locating pins on all the pieces drilled. The locating pins are flattened off to a depth of 1/16 inch from the outside circumference, and dimensions should be given from the flat to the center of the pin holes and to the center of the nearest or the most important of the holes to be drilled in the jig. The same strapping or clamping arrangements for the jig and work, as mentioned for the simpler form of jig, may be employed.

Improving the Jig by adding Locating Screws.

The next step toward improving the jig under consideration would be to provide the jig with locating screws, as shown in Fig. 68. By the addition of these, the locating arrangements of the jig become complete, and the piece of work will be prevented from shifting or moving sideways. These locating screws should be placed in accordance with Rule 10 laid down in the summary of the principles of jig design in the first installment of this series, in the April issue of MACHINERY, saying that all clamping points should be located as nearly opposite to some bearing points of the work as possible. In order to provide for locating set-screws in our present jig, three lugs or projections *A* are added which hold the set-screws. If possible the set-screw lugs should not reach above the surface of the piece of work, which should rest on the drill press table when drilling the holes.

The present case illustrates the difficulty of giving exact rules for jig design and indicates the necessity of individual judgment. It is perfectly proper to have two set-screws on the long side of the work, but in a case like this where the piece is comparatively short and stiff, one lug and set-screw, as indicated by the dotted lines at *B* in Fig. 68, would be fully sufficient. The strain of the set-screw placed right between the two locating pins will not be great enough to spring the piece out of shape. When the work is long and narrow two set-screws are required on the long side, but whenever a saving in cost can be accomplished without sacrificing efficiency, as in the case illustrated, two lugs would be considered a wasteful design.



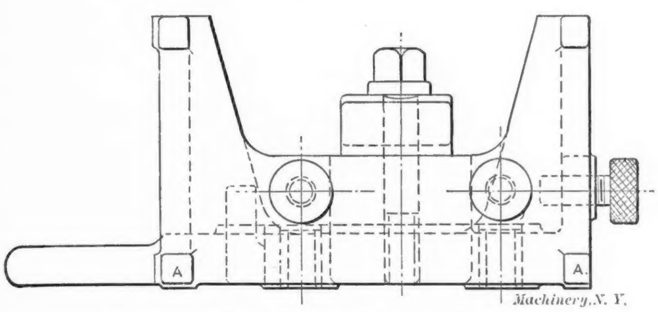


Fig. 67. Complete Jig for Rapid Duplicate Work.

Providing Clamps and Feet for the Jig.

The means by which we have so far clamped or strapped the work to the jig when drilling in the drill press (see Fig. 64) have not been integral parts of the jig. If we wish to add clamping arrangements that are integral parts of the jig, the next improvement would be to add four legs in order to raise the jig plate above the surface of the drill press table enough to get the required space for such clamping arrangements. The completed jig of the best design for rapid manipulation and duplicate work would then have the appearance shown in Fig. 67. The jig here is provided with a handle cast integral with the jig body, and with a clamping strap which can be pulled back for removing and inserting the work. Instead of having the legs solid with the jig, as shown in Fig. 68, loose legs, screwed in place, are sometimes used, as shown in Fig. 70.

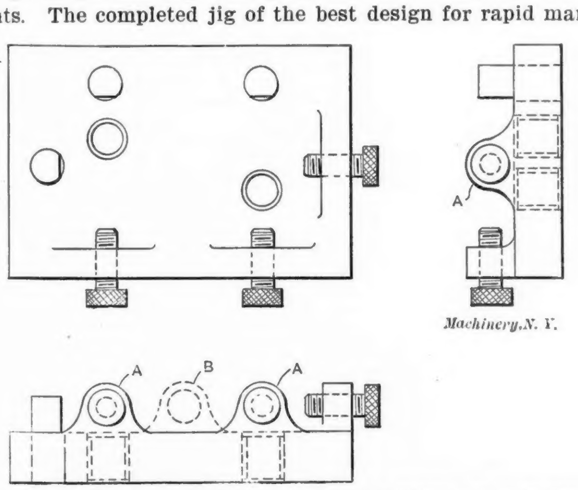


Fig. 68. Second Improvement: Locating Screws Holding Work in Place.

These legs are round, and provided with a shoulder *A*, preventing them from screwing into the jig plate. A headless screw or pin through the edge of the circumference of the threads at the top may prevent the studs from becoming loose. These loose legs are usually made of machine steel or tool steel, the bottom end being hardened and then ground and lapped, so that all the four legs are of the same length. It is the practice of many tool-makers not to thread the legs into the jig body, but to simply provide a plain surface on the end of the leg, which enters into the jig plate, and is driven into place. This is much easier, and there is no reason why for almost all kinds of work, jigs provided with legs attached in this manner should not be equally durable.

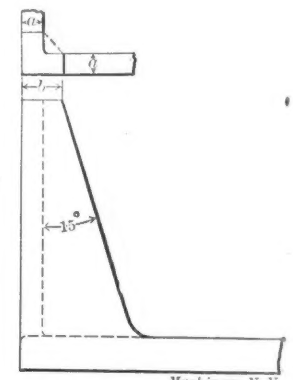


Fig. 69. Design of Legs for Cast Iron Jig Bodies.

Of course, when jigs are made of machine or tool steel, and legs are required, the only way to provide them is to insert loose legs. In the case of cast iron jigs, however, solid legs cast in place are preferable. The solid legs cast in place generally have the appearance shown in Fig. 69. The two webs of the leg form a right angle, which, for all practical purposes, makes the leg fully as strong as if it were made solid, as indicated by the dotted line in the upper view. The side of the leg is tapered 15 degrees, as a rule, as shown in the engraving, but this may be varied according to conditions.

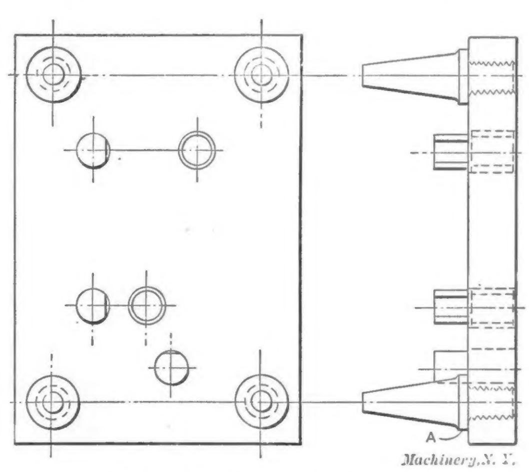


Fig. 70. Legs Screwed into Jig Body.

The thickness of the leg varies according to the size of the jig, the weight of the work, and the pressure of the cutting tools, and depends also upon the length of the leg. The length *b* on top is generally made 1½ times *a*. As an indication of the size of the legs required, it may be said that for smaller jigs, up to jigs with a face area of 6 square inches, the dimension *a* may be made from 5/16 to 3/8 inch; for medium sized jigs, ½ to ⅝ inch; for larger sized jigs, ¾ to 1½ inch; but of course, these dimensions are simply indications of the required dimensions. As to the length of the legs, the governing condition, evidently, is that they must be long enough to reach below the lowest part of the work and the clamping arrangement.

If a drill jig is to be used in a multiple spindle drill, it should be designed a great deal stronger than it is ordinarily designed when used for drilling one hole at a time. This is especially true if there is a large number of holes to drill

simultaneously. The writer has had sad experiences with drill jigs which would give excellent service in common drill presses for years, but which, when put on a multiple spindle drill, immediately broke to pieces as if subjected to a hammer-blow. It is evident that the pressure upon the jig in a multiple spindle drill is as many times greater than the pressure in a common drill press as the number of drills in operation at once.

Referring again to Fig. 67, attention should be called to the small lugs *A* on the sides of the jig body which are cast in place for laying out and planing purposes. The handle should be made about 4 inches long, which permits a fairly good grip by the hand. The design of the jig shown in Fig. 67 is

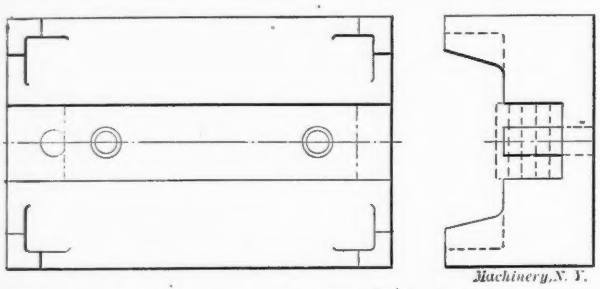


Fig. 71. Form of Jig which may be used for drilling a Number of Pieces Simultaneously.

simple, and fills all requirements necessary for producing work quickly and accurately. At the same time, it is strongly and rigidly designed. Locating points of a different kind from those shown can, of course, be used; and the requirements may be such that adjustable locating points, as described in the June issue may be required. A more quick acting, but at the same time, a far more complicated clamping arrangement might be used, but the question is whether the expense of making is warranted by the added increase in the rapidity of manipulation.

Another improvement which should not be overlooked, and which in a case like this probably could be made, and which it is always wise to look into at any rate, is: Can more than one piece be drilled at one time? In the present case, the locating pins can be made longer, or, if there is a locating wall, it can be made higher, the legs of the jig can be made longer, the screw holding the clamp can also be increased in length, and if the pieces of work are thick enough, set-screws for holding the work against the locating pins can be placed in a vertical line, or if the pieces be narrow, they can be placed diagonally, so as to gain space. If the pieces are very thin, the locating might be a more difficult proposition. If they are made of a uniform width, they could simply be put in the slot in the bottom of the jig, as shown in Fig. 71, or if

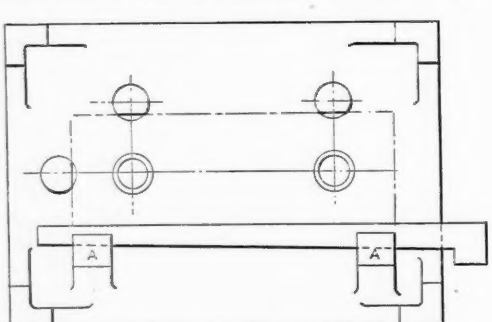


Fig. 72. Jig with Wedge for Holding the Work.

a jig on the principles of the one shown in Fig. 67 is used, they might be located sideways by a wedge, as shown in Fig. 72. A couple of lugs *A* would then be added to hold the wedge in place, and take the thrust. In both cases the pieces must be pushed up in place endways by hand. If the pieces are not of exactly uniform size, and it is desired to drill a number at a time, they must be pushed up against the locating pins by hand from two sides, and the clamping strap must be depended upon to clamp them down against the pressure of the cut, and at the same time prevent them from moving side or endwise. If the accuracy of the location of the holes is particular, the pieces should not be piled up on one another to be drilled.

TOOLS FOR THE BLACKSMITH SHOP.*

JAMES CRAN.†

Among mechanics, the blacksmith holds a unique position, he being practically the only one who makes his own tools. This he often does without any apparent aim at economy, beauty, or usefulness, if judged by the chunks of steel on the ends of handles to be found in the odd corners of a great many blacksmith shops. It would not be fair to put the whole blame on the blacksmith, as he is usually allowed but very little time either to keep his tools in repair or to make new ones; the result is that if ever blacksmiths' tools have had a high standard of efficiency, they soon depreciate. Too much reliance seems to be put on the old saying: "A good workman can do a good job with any kind of tools." But when it comes to saving time, which is one of the most important points in modern manufacturing, the good workman with good tools comes out ahead.

Tools used by blacksmiths do not have to be so accurate to size, or made with the same precision as those used by machinists or tool-makers. Still, some of the points most essential to doing good work seem to have been overlooked. It would be to the advantage of all concerned to have one smith in every shop do the tool-making. He would soon become an expert, and would make better tools in less time than the smith who makes a tool occasionally. It would also insure every man employed having equally good tools and equal chances of doing good work. Tools made by a good blacksmith are preferable to those upon the market for several reasons, the principal of which is the poor quality of the material of which the article on the market is made.

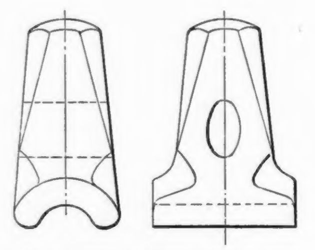


Fig. 1. Correct Form of Top Part of Blacksmith's Swage.

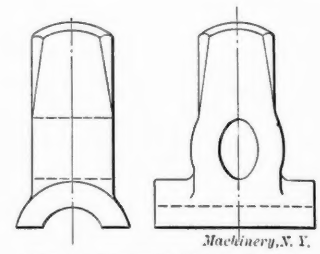


Fig. 2. Incorrect Form of Blacksmith's Swage, Top Part.

Besides, the blacksmith's tools on the market are often poorly constructed and are mostly used in small or country shops where there is no steam hammer.

Tools such as swages are usually made with the impression or hollow part too deep, the corners too sharp, and the face too long for the best results. Swages, being tools used for finishing round or semi-round work at the anvil after it has been drawn nearly to size at steam or trip hammers, should be constructed so that finishing can be done in the best and quickest manner possible. They should be made in pairs consisting of one top and one bottom piece. The depth of the impression ought to be about one-third the diameter of the piece the swages are intended to finish. The edges or lips of the impression should be well backed off, and all corners rounded to prevent cold shuts and unsightly marks being left upon the work. The swages may be slightly crowned from end to end, which will give them a tendency to draw the stock, should it be a trifle over size, and if the crowning is not overdone, it will help to leave the work smooth.

The bottom swage should be made to come flush with one side of the anvil, and to reach about half way across it. The swages can then be used for finishing hubs, bosses, forgings with large heads or arms, at right angles to the hub of the work. The bottom swage can also be reversed and used from the other side of the anvil when necessary. Bottom swages should preferably be a little longer on the face than the top swages. For small sizes they might be from 2¼ inches to 2½ inches from end to end of the impression, while the corresponding top swages might be about 1¾ inch. For larger sizes the bottom swage could be from 4 inches to 4½ inches

* See MACHINERY, June, 1908: Reasons Why so Little is Heard from Forge Shops; and August, 1908: System for the Blacksmith Shop.

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long and the top swage from $2\frac{1}{4}$ inches to $2\frac{1}{2}$ inches. The number and sizes to constitute a set for one forge would have to be determined by the size and class of work for which the swages would be used. The following list would cover the average range of machine blacksmithing: Top and bottom from 3/16 inch to 1/2 inch, inclusive, advancing by 1/16 inch; from $\frac{5}{8}$ inch to $2\frac{1}{4}$ inches, inclusive, advancing by $\frac{1}{8}$ inch; larger sizes up to the limit to advance by $\frac{1}{4}$ inch. Fig. 1 shows the correct style of top swage, and Fig. 2 an objectionable style. Fig. 3 shows the correct style of bottom swage, and Fig. 4 the incorrect style.

The shape and style of fullers is not so important from the fact that there can be no sharp corners to come in contact with the work. Care should be taken to make them in pairs which match each other perfectly. With bottom fullers it is well to have a large shoulder to rest on the anvil. The shank should be a snug fit to keep it from wobbling.

Flatters as a rule are too large and too level on the face for doing good work, and like swages are usually too sharp and square on the corners and edges. More and better work can be done with a flatter $2\frac{1}{2}$ inches square on the face than can be done with one 3 inches square face. When

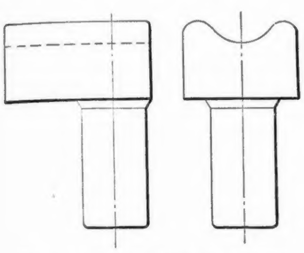


Fig. 3. Correct Form of Bottom Part of Swages.

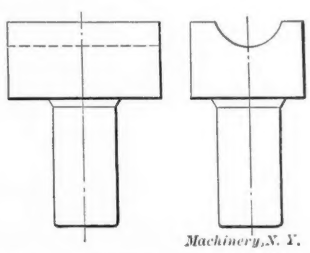


Fig. 4. Incorrect Form of Bottom Part of Swages.

a large level flatter is used, the edges come in contact with the work and leave a mark every time it is struck with a sledge. With a small flatter with crowning center and rounded edges a blow with the sledge will have more effect, and it will be almost impossible to leave a mark upon the work. The same principle applies to sets. The style best suited for machine blacksmithing should be from $2\frac{1}{4}$ inches to $2\frac{1}{2}$ inches long, and from $1\frac{3}{8}$ inch to $1\frac{1}{2}$ inch wide on the face. It would be of advantage to have one with the edges well rounded to use around fillets, and one with sharp square edges to finish corners which must be sharp.

Breaking-down tools should be made with the edge rounded, which will prevent the leaving of a cold shut where the shank

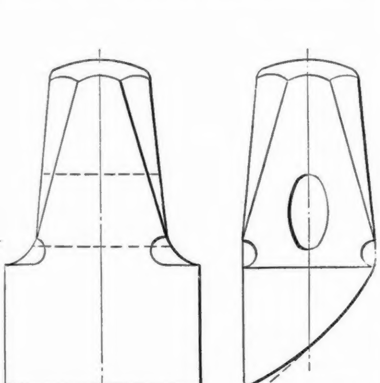


Fig. 5. Correct and Incorrect Shape of Blacksmith's Breaking-down Tool.

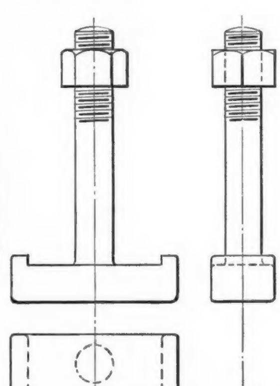


Fig. 6. Clamping Screw used with Clamp in Fig. 10.

joins the body of a forging. Fig. 5 shows the correct style in full lines; the dotted lines show the incorrect style. When square work is being drawn at the steam or trip hammer, it will sometimes become diamond shaped, and it is very hard to work it back to the square form without flattening two of the corners, unless a pair of V swages are used. These ought to have a place in every set of tools, the impression in both top and bottom to be 90 degrees, with the edges well rounded so that they would have their greatest bearing at the apex of the V. This forces out the other two corners of the work until it is perfectly square, without marking it. Chisels, punches, and gouges must be made to suit the work. The tools previously mentioned, with the exception of chisels, punches, and gouges, could be made of steel of about 0.60 carbon. All tools intended for cutting should be made of steel not less than 0.75 carbon.

Tools will give better service and satisfaction if hardened on both ends. The writer appreciates the fact that in recommending the hardening of the heads of tools he is laying himself open to criticism, as it is departing from all general rules and practice. Nevertheless, if the head of a

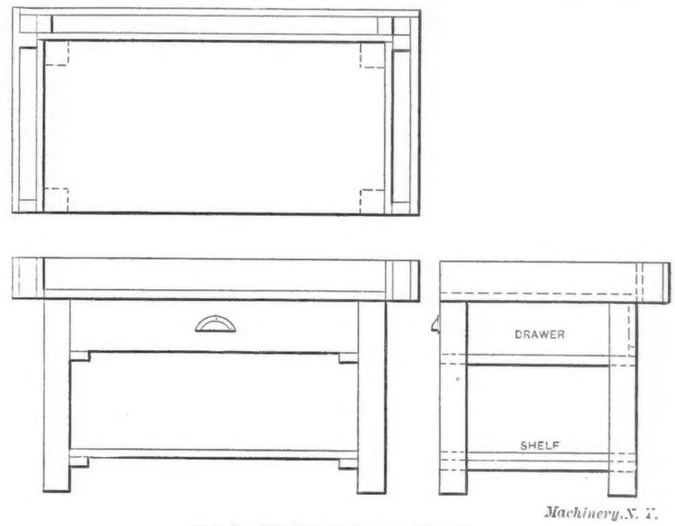


Fig. 7. Blacksmith's Tool Bench.

tool is properly hardened, the tool will give at least five times more service than a tool with a soft head. In hardening the working end of such tools as swages, flatters, etc., the face, after being heated to the proper temperature, should be cooled in a stream of water rising straight from the bottom of the quenching tub. Care should be taken to hold the tool so that the stream will strike its center, which will insure the center being hard. After the tool is cold enough to carry water on the face, polish, and draw the temper in a hot fire until the edges are a light blue, leaving the center as hard as possible. If hardened in a bath without a stream, the edges are liable to be extremely hard and the center soft.

When hardening the heads of tools, they should be heated to a cherry red about 1 inch of their length, dipped to a depth of about $\frac{5}{8}$ inch in water until fairly cooled, and then

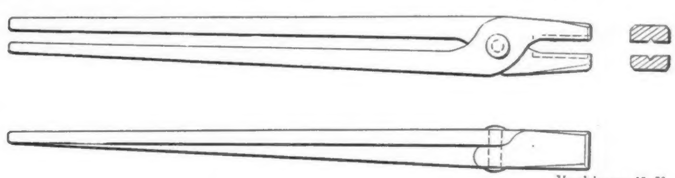


Fig. 8. Approved Type of Tongs with Flat Jaws.

the head polished and the temper drawn with back heat until the color just runs out. If much heat is left, dip slightly to check it, and leave the tool to cool off gradually in the air. Heads treated in this manner will neither chip off, nor crack, nor batter down.

Fig. 7 shows a tool bench which is of a suitable style for the blacksmith's tools. The rack around the top holds tools with handles; the shelf at the bottom accommodates bottom or anvil tools, and the drawer is used to hold such tools as are usually the personal property of the blacksmith, as well as orders, drawings, etc., which ought to be kept clean and out of the range of sparks. A bench of this style made of wood will give good service if the top edges of the rack are covered with light band-iron attached with screws. Every tool ought to have its own place on the bench, swages, fullers, etc., in consecutive arrangement, so that the blacksmith can put his hand on any tool at any time. It takes but very little time to put away a tool immediately after it has been used. If this is done every time, it will save confusion and lots of expressive language when it is wanted again.

The next tools to be considered are tongs. These are by no means the least important of the blacksmith's tools. In

order to do good work, it is of the utmost importance to have tongs which will hold the work firmly. In a great many cases tongs are poorly proportioned. For light work they are too heavy, and for heavy work they are too light. In making tongs, several things should be taken into consideration, such as the shape of the stock they are intended to hold, where to leave the most material to resist strain, and the parts most liable to wear out. For flat tongs the jaws should be heaviest near the joint, and taper toward the point. The point should be about half the thickness of the width of the jaw. The reins should be round on the edges and taper gradually from the joint to the tip, which will give them

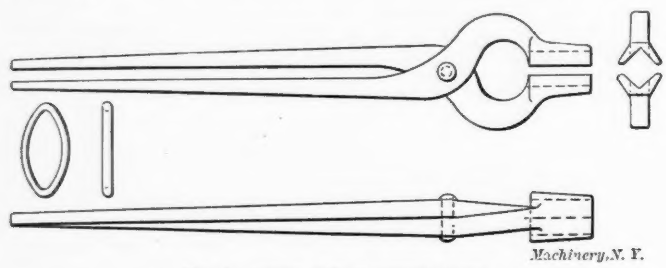
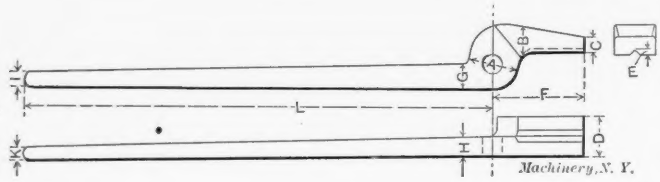


Fig. 9. Tongs with V-shaped Jaws.

elasticity, and afford a comfortable grip for the hand. Care should be taken to leave no sharp corners around the joint, as it is there that the tongs are most liable to break. Flat tongs should have a small V shaped impression the full length of he jaw, so that they can be used to hold square stock cornerwise, or round stock. Fig. 8 shows a pair of flat jawed tongs of about the proper proportion for holding ½-inch flat, ½-inch square or ⅝-inch round stock. Barring accidents this style ought to give the maximum of service. This type of tongues can be used for stock of the smallest sizes up to two inches. For larger sizes of flat stock the tongs ought to have one box jaw, or a jaw with a cross section on the point with lips turned up, to prevent the work from moving edgeways. The tongs shown in Fig. 9 are the most

DIMENSIONS OF FLAT-JAWED TONGS.

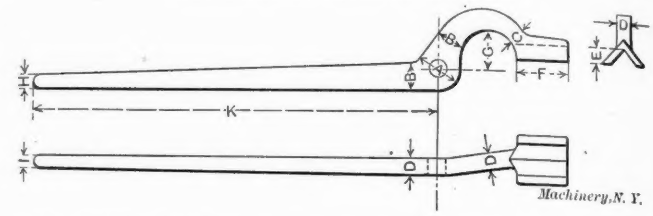


Nominal size of Tongs.	Diameter at Joint.	Thickness of Jaw at Base.	Thickness of Jaw at Point.	Width of Jaw at Point.	Depth of V.	Length of Jaw.	Width of Reins at Base.	Thickness of Reins at Base.	Width of Reins at Point	Thickness of Reins at Point	Length of Reins	Size of Rivet.
Inches.	A	B	C	D	E	F	G	H	I	K	L	M
0 – 1/8	5/8	3/8	1/4	5/8	1/16	2 1/8	1/2	5/16	5/16	1/4	14	1/4
3/16 – 5/16	3/4	7/16	5/16	5/8	1/16	2 1/4	9/16	5/16	5/16	1/4	15	1/4
3/8 – 7/16	7/8	1/2	5/16	3/4	1/16	2 1/2	5/8	3/8	3/8	5/16	16	5/16
1/2 – 5/8	1	9/16	3/8	7/8	3/32	2 3/4	11/16	7/16	3/8	5/16	18	3/8
3/4 – 7/8	1 1/8	5/8	3/8	1	5/32	3	3/4	1/2	7/16	3/8	20	7/16
1 – 1 1/8	1 1/4	11/16	7/16	1 1/8	3/16	3 1/4	13/16	9/16	1/2	7/16	22	1/2
1 1/4 – 1 3/8	1 3/8	3/4	1/2	1 1/8	1/4	3 1/2	7/8	9/16	1/2	7/16	24	9/16
1 1/2 – 1 5/8	1 1/2	3/4	1/2	1 1/4	3/8	3 3/4	1	5/8	5/8	1/2	26	5/8
1 3/4 – 1 7/8	1 5/8	13/16	9/16	1 3/8	7/16	4	1 1/16	11/16	5/8	1/2	28	5/8
2	1 3/4	7/8	5/8	1 1/2	7/16	4 1/4	1 1/8	3/4	11/16	1/2	30	11/16

convenient style for holding round or square stock, the V shaped jaws giving them a perfect grip on square work, and a bearing on four points of round work. This gives them an advantage over the circular jawed tongs commonly used for round stock, as these only have two bearings. The goose neck section between the jaw and the joint is also an advantage, as it will accommodate a burr or irregularity on the end of a piece of iron or steel which is usually found after it has been cut with shears or with a saw, while the bar is hot. Tongs of this shape can be used up to 5 inches capacity. For holding them upon the work, the style of link shown in Fig. 9 in enlarged scale in proportion to the tongs should be used. Being made narrow at the ends, it has the advantage of hugging the reins tightly, and having two bearings on each rein makes it less liable to fly off than the link with circular ends.

For work over 5 inches, the style of clamp shown in Fig. 10 should be used. This clamp can be bolted firmly to the

DIMENSIONS OF GOOSE-NECK TONGS.



Nominal Size of Tongs.	Diameter at Joint.	Width at Base of Goose-neck and at Base of Reins.	Width of Goose-neck near Jaw.	Thickness of Goose-neck and of Base of Reins.	Depth of Jaw.	Length of Jaw.	Depth of Goose neck from Center Line.	Width of Reins at Point.	Thickness of Reins at Point.	Length of Reins.	Size of Rivet.
Inches.	A	B	C	D	E	F	G	H	I	K	L
1/4 – 5/16	5/8	1/2	7/16	5/16	1/8	1	1/2	5/16	1/4	14	1/4
3/8 – 7/16	3/4	9/16	1/2	5/16	3/16	1 1/8	9/16	5/16	1/4	16	5/16
1/2 – 5/8	7/8	5/8	9/16	3/8	1/4	1 1/4	5/8	3/8	5/16	18	3/8
3/4 – 7/8	1	3/4	5/8	7/16	3/8	1 1/2	3/4	3/8	5/16	20	7/16
1 – 1 1/8	1 1/8	7/8	11/16	1/2	1/2	1 3/4	7/8	3/8	5/16	20	1/2
1 1/4 – 1 3/8	1 1/4	1	3/4	9/16	5/8	2	1	7/16	3/8	22	1/2
1 1/2 – 1 3/4	1 3/8	1 1/8	7/8	5/8	3/4	2 1/8	1 1/8	1/2	3/8	24	9/16
1 7/8 – 2 1/8	1 3/8	1 3/16	15/16	11/16	1	2 1/4	1 1/4	1/2	3/8	26	5/8
2 1/4 – 2 1/2	1 1/2	1 1/4	1	3/4	1 1/8	2 1/2	1 1/2	9/16	7/16	28	5/8
2 5/8 – 2 7/8	1 1/2	1 5/16	1 1/16	3/4	1 1/4	2 3/4	1 3/4	9/16	7/16	30	3/4
3 – 3 1/4	1 5/8	1 3/8	1 1/8	3/4	1 1/2	3	2	5/8	1/2	32	3/4
3 1/2 – 3 3/4	1 3/4	1 1/2	1 1/4	3/4	1 3/4	3 1/4	2 1/4	5/8	1/2	34	3/4
4 – 4 1/4	2	1 5/8	1 5/16	13/16	2	3 1/4	2 1/2	11/16	9/16	36	3/4
4 1/2 – 4 3/4	2 1/8	1 5/8	1 5/16	13/16	2 1/8	3 1/4	2 3/4	11/16	9/16	38	3/4
5	2 1/4	1 3/4	1 3/8	7/8	2 1/4	3 1/2	3 1/4	3/4	5/8	40	7/8

work whether it be round or square, and can be operated with the small clamps with handles attached to the shank in the same manner as would a porter bar. For heavy work, clamps are a great deal safer than tongs, and can be made to handle flat or irregular shaped pieces. For fastening the clamp to the work, the bolt shown in Fig. 6 is the most suitable, it having a cross head with lugs to keep it from turning, and it can therefore be tightened or unscrewed with one wrench.

In nearly every blacksmith shop there is work to be done which can only be accomplished with special tools about

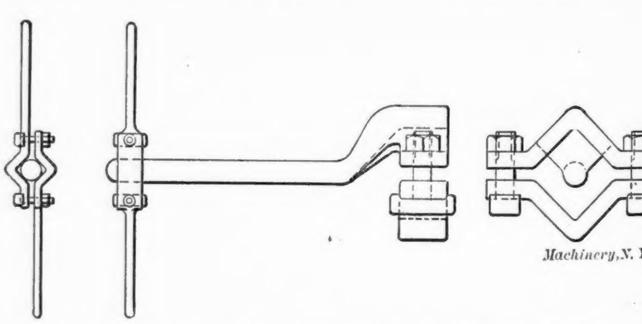


Fig. 10. Clamp for Handling Large Work in the Blacksmith Shop.

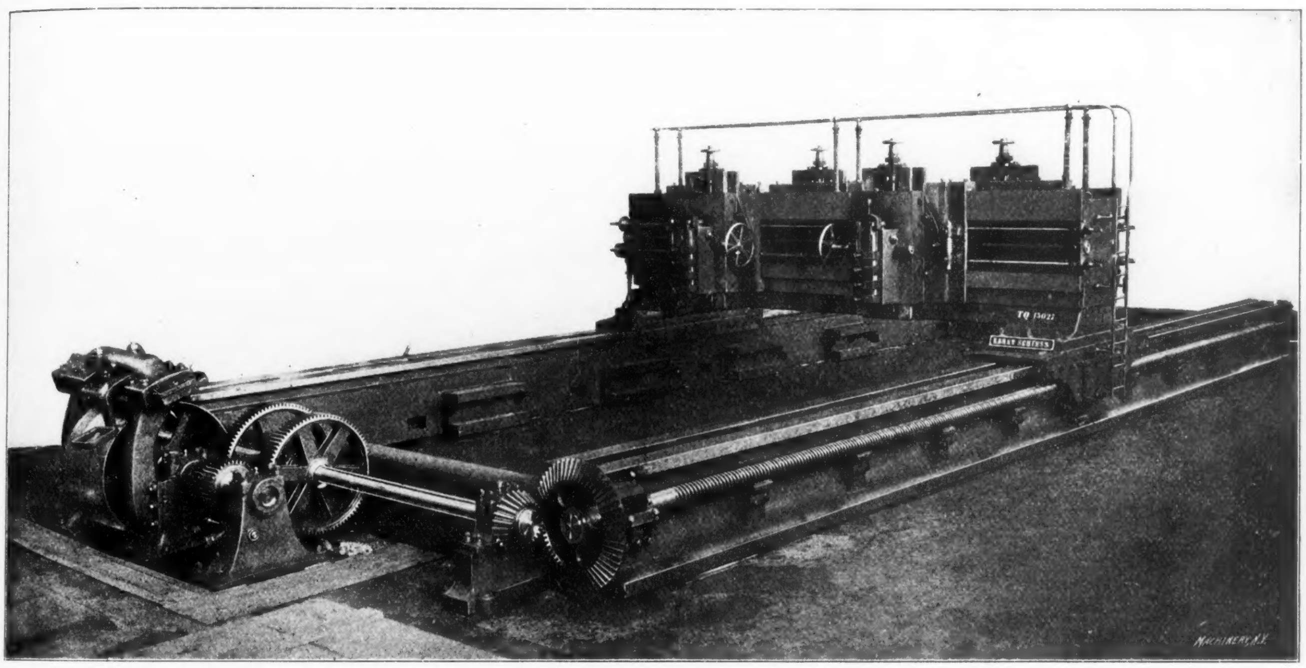
which it would be impossible to give any intelligent information without seeing the pieces to be made; but whenever the quantity is such that it will justify the making of special tools, it should be done. A former or a fixture will not only reduce labor and cost, but makes the work more uniform. It is no exaggeration to say that at the present time very few blacksmith shops give more than 75 per cent of their possible efficiency, and others not more than 50 per cent, simply for lack of tools, system, and good executive guidance. A little consideration and a little outlay of capital would be a good investment, as in the majority of cases it would raise the blacksmith shop from being a "drag" to one of the most remunerative departments in a manufacturing plant.

ERNST SCHIESS PIT PLANER.

We read with much interest your communication "An Alternative Planer Type Suggested" in your June issue, and your comments thereon. We would like to point out that the Société Anonyme des Etablissements Fetu-Defize, Liége, Belgium, is not, as might be inferred, the only firm building this sort of pit planer. We are building pit planers and have delivered machines built for similar purposes of 10 meters (32 feet 9¾ inches) length and 4 meters (13 feet 1½ inch) width, among others to Messrs. Schneider & Co. in Le Creuzot (three); Krupp, in Essen (two); Dillingen Hüttenwerke, Dillingen (two).

The accompanying illustration shows our machine which planes 8,000 millimeters (26 feet 3 inches) long, and 4,000 millimeters (13 feet 1½ inch) wide, and which is provided with four tool-posts. The side beds of the machine, each consisting of two pieces coupled together and bound at the ends by heavy cross ties, are made with flat guides for the cross-slide. The cross-slide is fitted with side strips on the inside edges for taking up the wear. The outside strips are to prevent side slipping of the cross-slide.

The drive is obtained through open and cross belts and steel spur and bevel gears connecting the two long heavy screws lying outside of the beds. These screws run in phosphor bronze bearings, and are provided with nuts filled with white hard anti-friction metal for driving the cross-slide. Two transmission shafts also run in phosphor bronze bearings. The length of the bed is 13,700 millimeters (45 feet, about).



Large German Pit Planer.

The machine is arranged to plane both forward and backward, and the cutting speed in both directions is 2 meters (6.56 feet) per minute for very hard material and 4 meters (13.12 feet) per minute for medium hard metals. The tool slides are self-acting and may be operated independently, either horizontally or vertically. The feed for each carriage is operated by means of a crank disk and movable connecting-rods. The horizontal feed motion of the main slides is so arranged that both slides can be operated together or independently in the same direction or in opposite directions, and the tool boxes can be set at any angle.

Ernst Schiess Werkzeugmaschinenfabrik Aktien-Gesellschaft.
Düsseldorf, Germany.

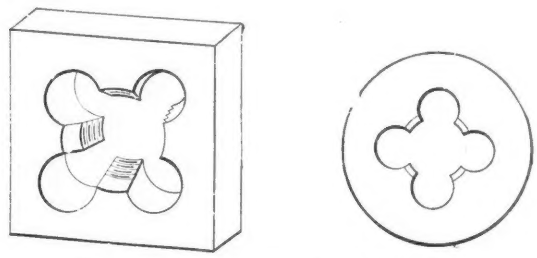
* * *

A new aluminum alloy has been patented in Germany by Walther Gosman, of the Krupp's Steel Works, of Essen-on-the-Ruhr, Germany. This alloy is composed of 87 per cent of aluminum, 8 per cent of copper and 5 per cent of tin. It is stated that the alloy casts better than the common aluminum and zinc mixtures, that it machines well, is homogeneous, and has a relatively higher ultimate strength.

THREADING DIES.

ERIK OBERG.*

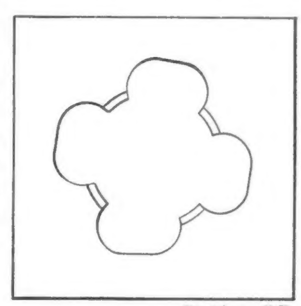
Threading dies may be divided into four general classes: Solid dies, which may be either square or round, as shown in Figs. 1 and 2; adjustable split dies, which usually are round; spring screw threading dies; and inserted chaser dies, where the blades, provided with cutting teeth, are inserted in the body, and secured in some suitable manner.



Figs. 1 and 2. Square and Round Solid Dies.

Solid Dies.

The solid die is used to a great extent on general work, either in cases where a correct size is not essential, or for roughing a thread before taking a finishing cut with an adjustable die. The solid die is not preferable to use when threads are to be cut requiring a high degree of accuracy. In the first place, the size when the die is hardened, cannot be depended upon to be exactly the size wanted, as dies are very apt to "go" more or less in hardening, and on account of their construction, apt to "go" in an irregular manner, one land closing up or departing more from the true axis of the thread than the others. In the second place, even if the die were correct from the beginning, there are no provisions for adjusting it to size when worn.



Machinery,N.Y.

Fig. 3. Large Size Square Solid Die, showing Form of Clearance Holes.

Solid Square Dies.

The solid die, as a rule, is of a square form. It is used principally for threading in bolt cutters, and for work of this kind answers its purpose well. It is also used for pipe dies, in which case the thread evidently must be tapered. As a tapered thread, in order to cut a thread smoothly and correctly, requires to be relieved in the angle, and, as the difficulties for relieving an internal thread like that of a pipe die, are very great, and it is not customary to

* Associate Editor of Machinery.

do so, pipe dies, and, of course, also all other taper dies, cannot be used for cutting the threads of taps, but can only be used for rough work on pipes and similar soft metal where a perfect thread is not essential.

Lands and Clearance Holes.

Solid square dies are always provided with four lands, excepting if very large, when five lands may be preferable. The width of the land should be about 1/12 of the circumference of the screw to be cut with the die, or approximately 1/4 of the diameter of this screw. The clearance holes should be laid

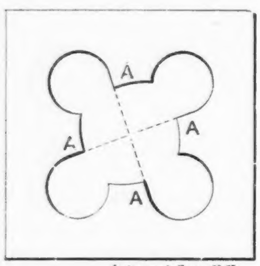


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Fig. 4. Cutting Edges as Ordinarily Made.

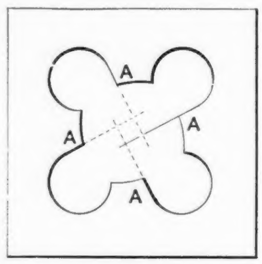

Fig. 5. Cutting Edges with Negative Rake.

out so as to provide for this width of land. The center of the clearance holes should be located a trifle outside of the circle which measures the diameter of the screw to be cut. Some makers of dies locate the center of the clearance holes exactly on this circle, but the clearance holes then become rather

TABLE I. DIMENSIONS OF SOLID SQUARE BOLT DIES.

Diameter of Thread.	Size of Square.	Thickness.	Diameter of Thread.	Size of Square.	Thickness.
$\frac{1}{4}$	$2\frac{1}{2}$	$\frac{1}{2}$	$\frac{7}{8}$	$2\frac{1}{2}$	$\frac{3}{4}$
$\frac{5}{16}$	$2\frac{1}{2}$	$\frac{1}{2}$	1	$2\frac{1}{2}$	1
$\frac{3}{8}$	$2\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{8}$	$2\frac{1}{2}$	1
$\frac{7}{16}$	$2\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{4}$	$2\frac{1}{2}$	1
$\frac{1}{2}$	$2\frac{1}{2}$	$\frac{3}{4}$	$1\frac{3}{8}$	$2\frac{1}{2}$	1
$\frac{9}{16}$	$2\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{2}$	3	1
$\frac{5}{8}$	$2\frac{1}{2}$	$\frac{3}{4}$	$1\frac{5}{8}$	3	1
$\frac{11}{16}$	$2\frac{1}{2}$	$\frac{3}{4}$	$1\frac{3}{4}$	3	$1\frac{1}{4}$
$\frac{3}{4}$	$2\frac{1}{2}$	$\frac{3}{4}$	$1\frac{7}{8}$	$3\frac{1}{2}$	$1\frac{1}{2}$
$\frac{13}{16}$	$2\frac{1}{2}$	$\frac{3}{4}$	2	$3\frac{3}{4}$	2

small, and are easily clogged with chips which may tear the threads of the screw being cut, and occasionally break the teeth of the threads in the die. In very large dies it is not possible to make circular clearance holes, as these would be required to be of too large a diameter in order to make the lands of the correct width. In such cases, two clearance holes are drilled between each two of the lands and connected with a straight surface, as shown in Fig. 3.

The chamfer on the top of the thread should extend for about three to four threads. It is necessary to relieve the dies on the top of the thread of the chamfered teeth, in order

TABLE II. DIMENSIONS OF SOLID SQUARE PIPE DIES.

Nominal Pipe Size.	Size of Square.	Thickness.	Nominal Pipe Size.	Size of Square.	Thickness.
$\frac{1}{8}$	2	$\frac{1}{2}$	1	3	$\frac{3}{4}$
$\frac{1}{4}$	2	$\frac{1}{2}$	$1\frac{1}{4}$	3	$\frac{3}{4}$
$\frac{3}{8}$	2	$\frac{1}{2}$	$1\frac{1}{4}$	4	1
$\frac{3}{8}$	$2\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{2}$	4	1
$\frac{1}{2}$	$2\frac{1}{2}$	$\frac{3}{4}$	2	4	1
$\frac{3}{4}$	$2\frac{1}{2}$	$\frac{3}{4}$	$2\frac{1}{2}$	5	$1\frac{1}{4}$
$\frac{3}{4}$	3	$\frac{3}{4}$	3	5	$1\frac{1}{4}$

to make the die cut. If the die should be expected to cut a thread close up to a shoulder, the chamfer, of course, would have to be made proportionally shorter.

As the clearance holes when drilled do not produce a desirable cutting edge on the face of the teeth, the front face must be filed after the holes are drilled. They are, as a rule, filed radial, as shown in Fig. 4. When the dies are used wholly for threading brass castings, and various other alloys of copper, it is common in many shops to give the face of the cutting edges a negative rake, as shown in Fig. 5. However, opinions differ widely as to the proper rake to give to the lands of threading dies, and it is probably as well to make the faces radial in all cases. As a matter of fact, the dies will cut all metals ordinarily used in a machine shop to full satisfaction if made in this manner.

Dimensions of Solid Square Dies.

In regard to the sizes to which solid square dies should be made, the outside dimensions evidently depend upon the sizes of the holders in which the dies are used. The thickness of the die should preferably not be made less than one and one-quarter times the diameter of the screw to be cut with the die, but manufacturers of dies do not, as a rule, make their dies fully as thick. The average rule is to make the thickness about equal to the diameter, at least for sizes of screws larger than 3/4 inch diameter. In Tables I and II are given

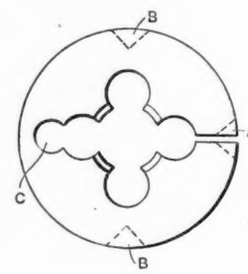

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Fig. 6. Round Split Adjustable Die.

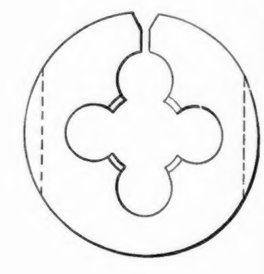

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Fig. 7. Round Split Adjustable Die with Grooves for Adjusting Screws.

the general dimensions of dies as commonly manufactured, both for regular sizes and pipe sizes. These dimensions are, of course, only given as a guidance, there being no particular reason for making the dies in these certain sizes excepting that the outside dimensions being standardized, the number of holders necessary to use with the dies are reduced to a minimum.

It is, however, necessary to call attention to the fact that, on account of the clearance holes, the size of the outside square must have some minimum relation to the diameter of the thread to be cut, so that the metal where the clearance

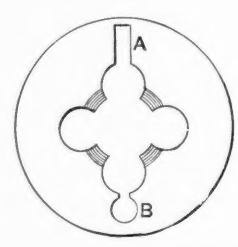

Fig. 8. Manner of Splitting Round Adjustable Die before Hardening.

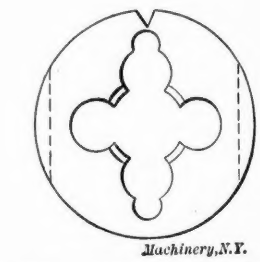

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Fig. 9. Round Adjustable Die before Hardening.

holes are drilled does not become too thin. Even if strong enough to stand the strain incident to the thread cutting operation, a die with too thin metal at the clearance holes will spring badly out of shape in hardening and will become a very poor tool for its purpose. The outside size of the square ought not to be less than double the diameter of the thread to be cut.

Number of Lands.

While four cutting edges or lands are sufficient, at least for all dies up to four inches diameter which cut a full thread, it is necessary to provide more than four cutting edges in a die used for threading work in which part of the circumference is cut away. A greater number of cutting edges are here needed in order to steady and guide the die, and prevent the work from crowding into the side where the metal is cut away. When more than one-sixth of the circumference is cut away, it is not advisable to try to use dies for cutting the thread. The number of cutting edges should be in relation to the amount of the circumference of the work cut away as follows:

Fraction of Circumference Cut Away.	Number of Cutting Edges.
1/24	5
1/12	6
1/8	7
1/6	8

Split Adjustable Dies.

Split adjustable dies, as said before, are usually round, as shown in Fig. 6. The split permits the die to be opened, or closed up, for adjustment. The countersink *A* at the split is for the point of the adjusting screw. The countersinks *B* are for the binding screws, which close up the die to bear upon the point of the adjusting screw. Instead of countersinking at *A* and *B*, as shown in Fig. 6, it is cheaper, when

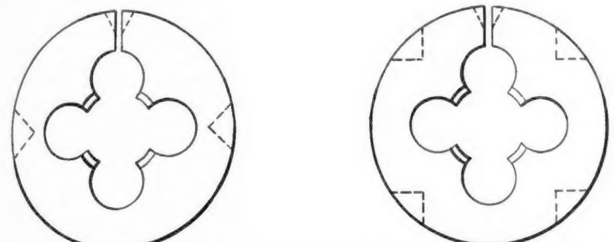


Fig. 10. Comparison between Common Ways used for Locating Adjusting Screws.

making these dies in quantities, to mill grooves, as shown in Fig. 7. The grooves, as well as the countersinks, for the adjusting screws, are usually made 60 degrees inclusive angle, and those for the binding screws 90 degrees.

In order to make the dies more easily adjustable, a small hole is often drilled outside of the clearance hole opposite the split, as shown at *C* in Fig. 6. If the dies made are few, they

TABLE III. DIMENSIONS OF DIE HOLDERS FOR USE IN ORDINARY LATHE.

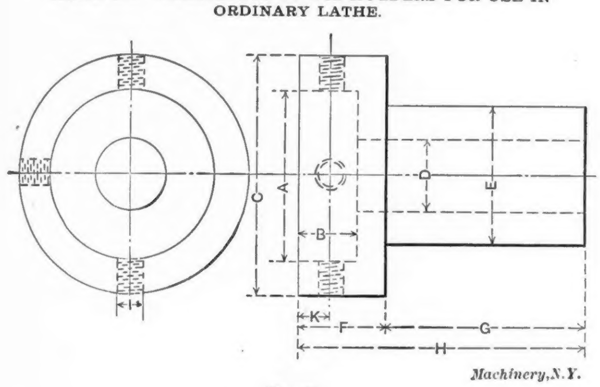


Fig. 11.

Diameter of Recess.	Depth of Recess.	Outside Diameter.	Diameter of Hole in Shank.	Diameter of Shank.	Length of Body.	Length of Shank.	Total Length.	Size of Screws.	Location of Screws.
A	B	C	D	E	F	G	H	I	K
0.632	1/4	1	3/16	1/2	3/8	3/4	1 1/8	5/32	0.135
0.821	1/4	1 1/4	7/16	7/8	3/8	3/4	1 1/8	3/16	0.135
1.009	3/8	1 1/2	9/16	1	9/16	1 1/8	1 11/16	7/32	0.197
1.511	1/2	2 3/16	13/16	1 3/8	3/4	1 1/4	2 1/4	1/4	0.260
2.013	5/8	2 7/8	1 1/16	1 3/4	15/16	1 5/8	2 13/16	5/16	0.322
2.515	11/16	3 9/16	1 3/8	2 1/8	1	2 1/16	3 1/16	3/8	0.354

may be split before hardening, as shown at *A* in Fig. 8, with a saw or narrow file, but should not be split all the way through until after hardening, in order to prevent springing due to this process. When made in large quantities, a hole may be drilled outside of the clearance hole, where the split is to come, and the groove for the adjusting screw milled so as to leave a narrow bridge of metal between the hole and the bottom of the groove, as shown in Fig. 9. This bridge of metal is then removed after hardening by means of grinding with a thin emery wheel, or a bevel wheel with an acute angle.

Round split dies for sizes up to and including 3/16 inch are given only three lands. All other sizes are provided with four lands. When hardening these dies, draw to a blue in back of the clearance holes, in order to insure a good spring temper.

About three threads should be chamfered and relieved on the top of the chamfer, on the leading side of the die. Such dies as are intended for use in die stocks should be chamfered on both sides or ends, in order to permit the turning of the die and its cutting close up to a shoulder. In such cases the chamfer on the leading side should be about three threads as before, and on the back side from one to one and one-half thread. The thread which is to be cut close to a shoulder should, however, always be started with the leading side of the die, both because this side is provided with a longer chamfer and consequently possesses better cutting qualities, and because of the guide with which the die stock is provided on the leading side which is necessary to insure a straight thread.

There is some difference of opinion as to the best manner of arranging the binding screws for adjustable split dies. The common arrangement with two screws has been referred to, but an arrangement for four screws, as shown in Fig. 10, evi-

TABLE IV. DIMENSIONS OF ROUND SPLIT ADJUSTABLE DIES.

Diameter of Thread.	Outside Diameter of Die.	Thickness	Diameter of Thread.	Outside Diameter of Die.	Thickness.
1/16	13/16	1/4	1/2	2	5/8
1/8	13/16	1/4	9/16	2	5/8
3/16	13/16	1/4	5/8	2	5/8
1/4	13/16	1/4	11/16	2	5/8
3/16	1	3/8	3/4	2	5/8
1/4	1	3/8	11/16	2 1/2	11/16
5/16	1	3/8	3/4	2 1/2	11/16
3/8	1	3/8	13/16	2 1/2	11/16
7/16	1	3/8	7/8	2 1/2	11/16
3/8	1 1/2	1/2	1	2 1/2	11/16
7/16	1 1/2	1/2	1 1/8	2 1/2	11/16
1/2	1 1/2	1/2	1 1/4	2 1/2	11/16

dently will close up the various lands more uniformly, and the die will cut more freely. If adjusted so that the lands do not come at a uniform distance from the true axis of the die, all the lands will not cut, or, if they cut, will produce a thread that will be out of true.

The outside dimensions of round split dies are usually made of certain standards to fit a few holders. Dimensions commonly used are stated in Table IV.

Die-holders.

An ordinary lathe die-holder is shown in Fig. 11, and dimensions for holders of this design for the dies in Table IV are given in Table III. A holder for a smaller size is also specified, as dies for small machine screw sizes are often made with an outside diameter of 5/8 inch and a thickness of 1/4 inch. The dimensions cannot, perhaps, always be adhered to, but they will be of value as guidance when proportioning holders of this or similar kinds.

It will be noticed that the center line of the binding screws does not fully coincide with the center of the die in the longitudinal direction, but that the screws apparently are located 0.010 inch too far in. This is for the purpose of forcing the dies solidly toward the bottom of the recess, the screws exerting a wedge action on the dies in the countersinks or milled grooves provided for the point of the screws.

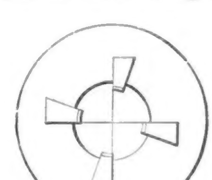


Fig. 12. Solid Inserted Blade Die.

Approximate formulas may be given from which well-proportioned holders for other sizes than those given in the table may be made. In the formulas:

d = the outside diameter of die,
A = diameter of recess,
B = depth of recess = thickness of die,
C = outside diameter of holder,
D = diameter of hole in shank,
E = diameter of shank,
F = length of body,
G = length of shank,
H = total length,
I = size of adjusting and binding screws, and
K = distance from end of holder to center of screws.

The following formulas give results, approximately, as stated in Table III:

$$A = 1.004\,d + 0.005 \text{ inch}$$

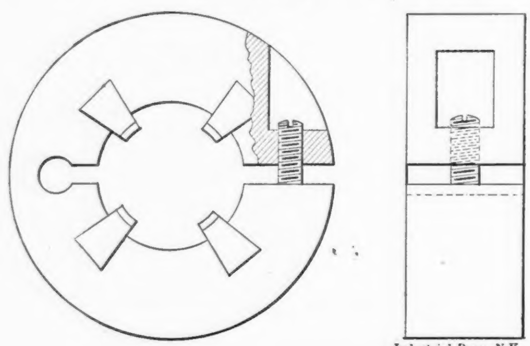
$$C = \frac{11\,d + 1}{8}; \qquad D = \frac{9\,d}{16}; \qquad E = \frac{3\,d + 1}{4};$$

$$F = \frac{3\,B}{2}; \qquad G = 3\,B; \qquad H = \frac{9\,B}{2};$$

$$I = \frac{d}{8} + \frac{3}{32}; \qquad K = \frac{B}{2} + 0.010.$$

Inserted Chaser Dies.

Inserted chaser dies may be of two kinds, such as have the chasers driven solidly in place, and such as have chasers



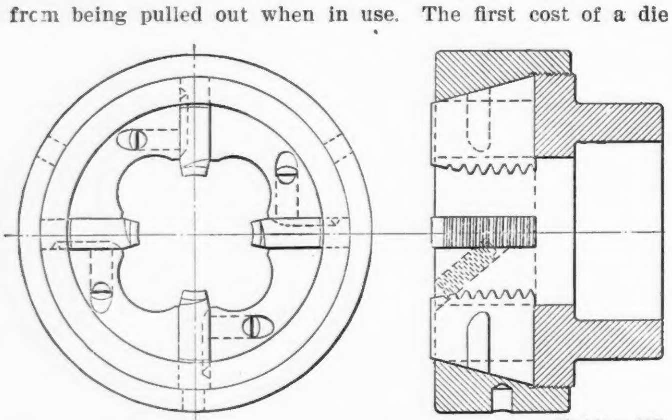
Industrial Press, N.Y.

Fig. 13. Adjustable Inserted Blade Die.

which are easily removable, and can be replaced without difficulty. It is evident that the latter form is superior, but it is also the more complicated and expensive form.

Inserted Chaser Dies with Fixed Chasers.

If we first consider the case of the dies with the blades solidly in place, we may safely say that it is not advisable to attempt to make very small dies with inserted blades, but for dies which are two inches in diameter, or possibly 1¾ inch, a ring of machine steel, having slots in which are inserted blades made of tool steel, is the simplest construction of an inserted blade die. The slots receiving the blade are made so that the front edge will be radial, as shown in Fig. 12. In this way there will be no difference in the cutting action of the inserted blade die, and a solid die having its cutting edges on the radial line. The slots should be of the dovetail type, that is, wider at the bottom than at the top, so that the blade is drawn into its seating surface, and prevented from being pulled out when in use. The first cost of a die



Machinery, N.Y.

Fig. 14. Inserted Chaser Die with Removable Blades.

made in this manner may not be any less than the first cost of a solid die, but the cost of new blades is less than the cost of a new solid die, and therefore, in the long run, this type of die should be cheaper. Besides, there is no risk of spoiling the dies in hardening, because only the blades are hardened, and these, of course, would not crack, at least not under any ordinary circumstances. The inserted blade dies are made either solid or adjustable. When made of the former type, they are threaded with a hob of exactly the same size as the screw to be cut with the die. When made adjustable, they should be tapped with a hob about 0.005 inch over size for a 20-pitch thread to about 0.015 over size for a screw having from 4 to 5 threads per inch. There are several methods for adjusting inserted blade dies, one of the simplest, and at the same time one of the best, is shown in Fig. 13, but it is claimed by many mechanics that better results are obtained if this class of die is provided with the same adjustment as has been previously described under the head of adjustable dies in the previous portion of this article.

Inserted Chaser Die with Removable Blades.

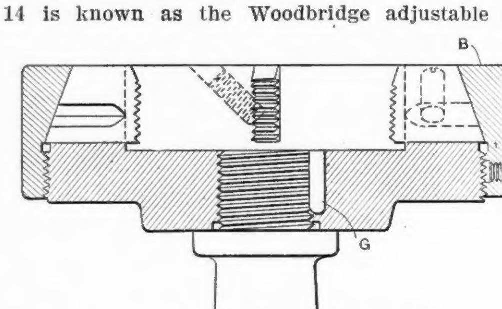
A typical construction of inserted chaser die with easily removable blades is shown in Fig. 14. This die consists of four chasers or blades inserted in radial slots in a body or

TABLE V. OVER-SIZE OF TAPS FOR HOBBING SPRING SCREW DIES WHEN CUT STRAIGHT.

No of Threads per inch.	Over-size.	No of Threads per inch.	Over-size.	No. of Threads per inch.	Over-size.
4½	0.015	12	0.006	28	0.004
5	0.013	13	0.006	30	0.004
5½	0.012	14	0.005	32	0.004
6	0.010	16	0.005	36	0.004
7	0.008	18	0.005	40	0.003
8	0.007	20	0.005	48	0.003
9	0.007	22	0.005	56	0.0025
10	0.006	24	0.004	64	0.002
11	0.006	26	0.004	72	0.002

collet, the chasers as well as the collet being enclosed in a die-ring. This ring is beveled on the inside to fit a corresponding bevel on the back of the chasers. It can be screwed up or down on the collet, thus pushing the chasers in toward, or permitting them to recede from, the center. Screws are provided bearing in slots of the chasers for holding the latter in place after they have been adjusted by means of the ring.

The chasers must, of course, be made in sets so that each is, so to speak, one-quarter of a thread ahead of the following one, or in other words, the teeth on the chasers must all form one continuous thread around the die. The die shown in Fig. 14 is known as the Woodbridge adjustable die. The



Machinery, N.Y.

Fig. 15. Another Type of Inserted Chaser Die with Removable Blades.

shank is in one solid piece with the body. Another form of inserted chaser die is shown in Fig. 15. Here the shank is screwed into the body and secured to it by means of a pin G. The screw A serves the purpose of locking the die ring B to the body as soon as the chasers are properly adjusted; the chasers are secured the same as in the die previously described.

The object of inserted chaser dies is the adjustment possible, and the saving caused by being able to use the same body and ring for an indefinite period, the chasers only being replaced when worn. The chasers only are made from tool steel, the remaining parts being machine steel. As there is a considerable element of waste in being obliged to throw away a solid or adjustable die made from expensive steel whenever the cutting edges are worn away, the economy of replacing the cutting edges only is obvious.

Spring Screw Threading Dies.

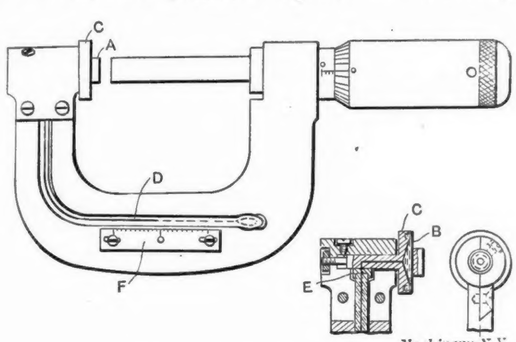
In the August, October, and November, 1906, issues of MACHINERY, three articles appeared dealing with the design and making of spring screw threading dies. In these articles, the commonly employed methods of making these dies were outlined, and some suggestions given in regard to possible improvements. In Table V is given the amount of over-size which the die tap is required to be when hobbing out spring screw dies, when threaded straight from the front of the die.

An article giving the method of determining the relative sizes of roughing and finishing spring screw dies was published in MACHINERY, March, 1907.

ITEMS OF MECHANICAL INTEREST.

SENSITIVE INDICATING MICROMETER.

The accompanying illustration shows a micrometer which has been patented by the General Electric Company, of Schenectady, N. Y. The object of this tool is to avoid dependence on the sense of touch of the person handling the measuring tool. In the instrument shown, the accuracy of the reading is independent of the sense of touch or experience of the operator, and a correct reading can be easily detected by the eye by means of an indicator. The principle of the device is simply this: The stationary member or anvil *A* is attached to a circular diaphragm *B*, which is supported on its circumference in the head *C*. This head is cut away, so as to form a cone-shaped depression, which, in connection with the diaphragm forms a receptacle for mercury. The head *C* is provided with a stem, which fits into a bearing in the micrometer frame, and is slightly adjustable. A capillary tube *D* is partially imbedded in the frame, and has one end screwed to the stem of *C*, by means of a collar *E*. An adjustable scale *F* is arranged at the center of the frame. When measuring, the object to be measured will be pressed against the anvil *A*, until the mercury in the tube reaches the zero graduation on the scale *F*. For every piece measured the micrometer screw will be screwed down until the pressure on the anvil equals the standard pressure required for the mercury to

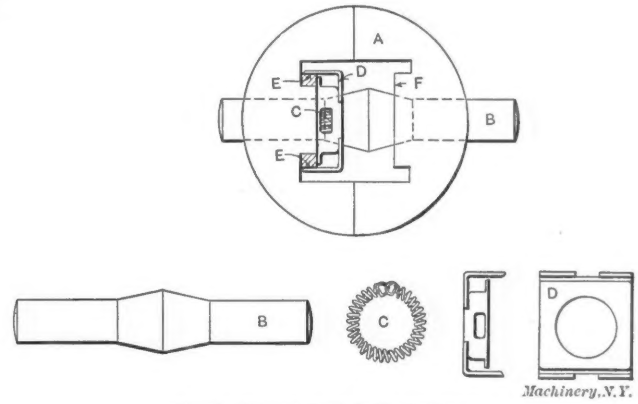


Sensitive Indicating Micrometer.

indicate at zero on the scale. The tube, of course, must be made of glass, so as to make the mercury column inside visible to the eye. It is evident that very close measurements can be obtained in this way. One objection to the instrument may be that it must be held in a vertical, or nearly vertical, position when in use. The principle involved, however, may possibly be used for other micrometer measuring instruments, where the dependence on the sense of touch is objectionable.

INGENIOUS ELECTRIC SWITCH MECHANISM.

The accompanying line engraving shows an electric switch mechanism, the interesting feature of which is the simplicity of its action. In the top view the mechanism is shown assembled, and below are shown the three main details, the casing *A* not being shown here. Disregarding the casing, the switch mechanism consists practically of only three parts: first, a push bar *B* extending clear through the switch, having its largest diameter in the center, and shaped conically from the center for some distance towards each end, as clearly shown in the illustration; second, a coil spring *C* which encircles the bar previously mentioned in such a manner that the axis of the spring forms a circle around the bar; third, a moving contact piece *D*, forming a casing over the spring. When this contact piece is in the position shown in the upper view, it is in contact and forms a circuit at *E*, the contact pieces in the casing *A* being shown cross-sectioned for the sake of clearness. The action of the device is simply this: when the bar is pushed forward, the coil spring rides up on the conical surface until it reaches the center of the bar, all the time preventing the contact piece from releasing from contact at *E* until the spring has reached the central and highest part of the bar. At this moment it suddenly contracts and moves swiftly along the conical shape on the other side of the highest point of the bar, carrying with it the moving contact piece *B* and releasing it from its contact at *E*, bringing it against the other side of the casing at *F*. It is not possible to move the contact piece part way and let it slip back again, drawing an arc which burns the contacts and eventually destroys them. The contact piece must be either positively in contact at *E* or out of contact, resting against *F*. The simplicity of the mechanism makes it particularly interesting, and no doubt devices using the principle

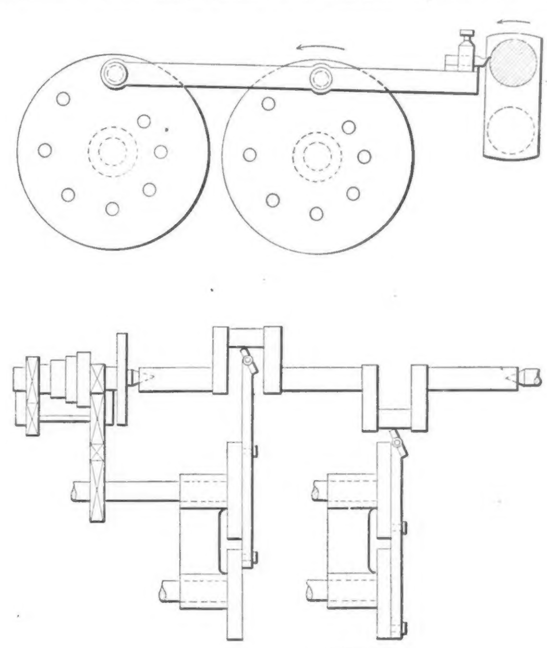


Simple Electric Switch Mechanism.

employed would be successful in automatic machinery for positive and instantaneous "knock-outs" and stops of various descriptions. The switch mechanism as shown is made by the Cutler-Hammer Mfg. Co., Milwaukee, Wisconsin.

CRANK TURNING DEVICE.

Patents have been applied for in Great Britain for the device working on the principle shown in the line-engraving herewith, intended for turning crank-pins, and pieces rotating around a central shaft in a similar manner. In the upper part of the figure, the general principle of the device is indicated, the lower part being a plan view showing diagrammatically its connection with the lathe to which it is applied. The principle of the device is easily seen from the illustration. The crank-shaft is mounted on its own centers



A Crank Turning Device of Novel Design.

in the lathe, and the working tools are given a reciprocating motion, vertically and horizontally, so as to coincide with, or follow, the motion of the work being turned. The motion of the tool is positive, and interdependent of the motion of the crank or shaft. In the lower part of the engraving, the device is shown in two positions, first when operating on one and then when operating on the other crank-pin of a crank-shaft having two pins. While not shown in the engraving, the two disks to which the tool holder arm is connected must be positively geared together, as otherwise difficulties are sure to be encountered. To what extent a device of this kind will prove practical for the purpose for which it is intended it is difficult to say.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

SEPTEMBER, 1908.

PAID CIRCULATION FOR AUGUST, 1908, 20,577 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

The fourteenth volume of MACHINERY, regular edition, was completed with the August issue, and the yearly indexes for the Engineering, Shop and Railway Editions will be ready in September. The reader who binds an index with his issues for the year will have a volume of mechanical knowledge without a parallel in smallness of cost and comprehensiveness of contents. Copies of the index are sent free; specify the edition wanted.

* * *

THE VALUE OF PUBLICITY TO INDIVIDUALS.

Once in a while some contributor who has sent us a valuable article, and to whom we think is due all the publicity resulting from its publication, objects to having his portrait and biography, and sometimes even his name, used in connection with his contribution. His objection usually arises from modesty and the lack of appreciation of the value to him personally of the kind of publicity afforded by a mechanical journal of large circulation. There are hundreds of able men in as many different shops in the country who are working for far less compensation, or at least under far less favorable circumstances, than they might, did some other employer (or, in fact, in many cases, even their own employer) know of their ability, and thereby feel warranted in offering them places of responsibility which they cannot now reach, simply because they lack the requisite advertising.

It is not enough that a man is an able man, that he does his work carefully and conscientiously, and that he is able to carry out the tasks given to him. To be really successful, it is also necessary that other people know of this ability and appreciate it; and one of the simplest and easiest ways for a person to become known among mechanical men is by presenting his work and his experience in the pages of trade journals. In this manner he reaches mechanical men all over the country, he develops his ability to think and write clearly and logically; and in some cases, too, he finds out his limitations, and thereby is given an opportunity to improve.

A manufacturer's product may be the most perfect in his line and still his sales may be far less than his competitor's, who, perhaps, turns out inferior work. The reason for the difference is simply that the former manufacturer does not advertise his goods adequately, or in a proper manner. In the same way, an individual may possess great ability, fitting him for authoritative positions, but nobody knows of him, simply because he lacks the requisite publicity. There are three stages, one might say, in a man's success; the first, to "make good"; the second, to let others know that he can make good; and the third, to continue to make good.

* * *

PRACTICAL KNOWLEDGE OF SALESMEN.

The practical knowledge possessed by salesmen of the construction and use of the machines which they represent and sell, is a factor that is not so fully appreciated as it ought to be. When a salesman does not possess any practical or technical knowledge regarding his machines, but is merely a good talker, he may be successful as long as he deals with people interested merely in the selling end of the business; but nearly always he will have to deal also with men who are mechanics in the first place, and who soon find out the shortcomings of the salesman, and realize that most of what he says is not the result of his own knowledge, or matters which he could himself verify, but is simply said because others have told him so. The practical man is at once prejudiced against dealing with a man of this type, and although the salesman may be both honest and able in his particular line, and represent the very best machines, his lack of mechanical knowledge may prove to be his undoing. It is therefore important, in order that the salesman may make a good impression upon his customers, that he should know in detail the mechanical construction and use of the machine he is trying to sell, and be able to point out, from his own experience, the reasons why it is superior to competing machines. Salesmen of this type are able to convince practical men, and they create a good impression. The firm employing such salesmen has in them one of its greatest assets.

* * *

THE ADVANCE OF ENGINEERING EDUCATION.

The new departure in engineering education, inaugurated two years ago at the University of Cincinnati, in the form of a cooperative course in engineering, appears so far to have proved an unqualified success. It is natural that it should be so, considering that the factors required in the training of an engineer have been taken care of by this course in a far better manner than by engineering schools in general. It should be remembered, however, that a cooperative course of this kind cannot be instituted by every technical school or college. The fundamental requirements are that the college be located in a city with a highly developed machine industry, and that the men in charge of these industries be favorably inclined towards the proposition, and willing to accept students for training purposes. But wherever the technical school is so located, there is little doubt that such a school will turn out a product superior to the average, and that it will receive applications from young men wanting a practical engineering training, in such abundance as to make possible a judicious selection of the raw material that is offered. This, at least, has been the experience of the Cincinnati school.

The advantages of the cooperative course, from a technical and mechanical point of view, can hardly be overestimated. This system of educating engineers is also likely to have far-reaching sociological results. It brings those men who in the future are to guide and superintend the work of others, in close contact with the very men they are to lead later on. It gives the students a clear conception of the conditions under which these men work, and should enable them as leaders to avoid a great deal of the friction that is often due simply to misunderstanding. This departure in engineering education should therefore be productive of results more far-reaching than even its inaugurators have anticipated. It has proved embarrassing in some cases to the old school of professors and teachers. They have found themselves out of place when confronted by young men who one week work in the shop, and the next week in the class-room, and who come there full of practical ideas. This experience will naturally force some instructors either to assume a different attitude toward practical education, or to make way for another class of instructors able to meet the demands of the times. The cooperative engineering courses are likely to be a regenerative force in our engineering education.

INCREASED USE OF HIGH-SPEED STEEL.

The main disadvantage under which high-speed steel has labored during the last few years, as regards its employment universally in the metal trades, has been its high cost. With the steel used merely as a cutting tool, this high cost would not be prohibitive, inasmuch as the increased production would well warrant the use of high-speed steel; but a large portion of every tool is used not as a cutting tool, but merely as a holding device, shank, etc., and it is rather expensive, particularly in large tools, to have these parts of the tool made of so expensive a material. Tool-holders of various shapes and kinds have been used, but for many purposes they are not as satisfactory as a solid tool. For this reason, attempts have been made to weld high-speed steel to shanks of cheaper materials, but in the past these attempts have been unsuccessful, the high-speed steel having refused to comply with any welding process intended to combine it by cohesion to either carbon steel or machine steel. An abstract of an article in an English contemporary in our Engineering Review this month gives a short review of a welding process which has been developed in England, and which is claimed to give satisfaction. Should it prove that this welding process is all that has been claimed for it, it is likely to revolutionize the use of high-speed steel, and in cases where now the expense of this material has been looked upon as prohibitive, it is likely to become universally used. It is to be hoped that the welding process, as outlined, is not merely a process developed for company promoting and stock jobbing purposes, but that it will prove to be of actual importance to the metal trades.

* * *

THE INCONSISTENCY OF SOME MANUFACTURERS.

JOHN B. SPERRY.*

Other manufacturers, besides machine tool builders, would do well to follow the suggestions offered in the editorial on "Obsolete Tools in Machine Tool Shops" in the July number of MACHINERY. The writer can call to mind several instances where manufacturers show their inconsistency in this respect. This can be best illustrated by a specific case, referring to a concern capitalized at $300,000, and manufacturing steam engines, air compressors, water in-takes operated by compressed air, air-lift systems, centrifugal pumps of all sizes, and several other kinds of machines for pumping purposes. This firm has a machine shop, foundry, wood shop, pattern shop, blacksmith shop, and ware-house—all modern buildings. These shops all receive their power from a central power plant equipped with a Corliss engine and a direct current generator. The machine shop is equipped with an electric traveling crane, while the foundry and blacksmith shop have jib cranes operated by hand. The concern has spent thousands of dollars for jigs in order to lower the cost of production. The shops are lighted by electricity, and the clock system of time keeping has been installed. Besides this, there is an excellently arranged stock department.

Contrasted with this is the equipment of the foundry. Since this firm manufactures air compressors, one would naturally expect to see some pneumatic tools in operation, especially in the foundry; but no, all the riddling and chipping is done by hand. Pieces that are too large to put in the rattler are brushed and cleaned up by hand. And to cap the climax, instead of using one of the firm's own air-lift pumps for the water system, there is an old power pump jack that keeps the water well oiled, and breaks down regularly once every two weeks.

Now this firm's trade in air compressors has fallen off considerably in the last two years, due, it is claimed, to the competition in that line. It is the writer's opinion that if this firm would practice what it preaches, it would be able to get in on the ground floor with the other fellow. The use of air hammers, air chisels, air brushes, sand blasts, emery wheels operated by air, air drills, riddles operated by air, and air lifts, would not only cheapen the labor cost, but the practical application of compressed air to the work of the machine shop, foundry, blacksmith shop, etc., would be an object lesson to the intending purchaser that would tend to hasten his decision.

This shop is not the only one that seems to be trying to make and sell something that the firm's officers do not seem to believe in themselves; there are others, and one does not have to travel far to find them. Without citing any more cases one might add that if the manufacturer would be consistent and make it a point to have practical applications of the machines or appliances that he manufactures, where they can be seen by a buyer, he will find it easier to convince the public of the utility and advantages offered by his product.

[In connection with the foregoing it may be interesting to relate an occurrence which took place at the works of a well-known machine tool building firm a few years ago. A Japanese, traveling in the United States for the purpose of selecting and buying some new machinery for a Japanese ordnance works, was taken through the shops by one of the members of the firm, and shown a new lathe brought out by the company. This guide, having a mental vision of a large contract from the Japanese government, became more and more enthusiastic as he explained the merits of the new machine, and, in particular, pointed out that no machine shop could afford to keep their old machines, when installing this new lathe would double the production, or nearly so. He explained to the Japanese that in America it was very common for manufacturers to throw out the whole of their old equipment, and install new machinery when its superiority had been proved. This particular machine, he said, was a machine of the type that would justify such action. The Japanese listened with a pleasant smile, and, according to the Japanese code of politeness, agreed with everything said. After having been taken all through the shops, and on return to the office, when the question of "making a deal" was brought up, the little Japanese quietly and pleasantly asked: "Now, if this machine that you have shown me, and the merits of which are so great as to warrant throwing out old equipment and installing a new set of machines, actually possesses all the merits you claim for it, how is it that you have only three of these new lathes installed in your own shop?" The reply is not recorded, nor is the sale of the machines.—EDITOR.]

*Address: 583 Benton St., Aurora, Ill.

* * *

SPECIFIC ADVERTISING.

The great advance in machine tool construction which has taken place during the last decade is strikingly demonstrated by a comparison of the advertising pages of a technical journal ten years ago and to-day; and such a comparison will show not only that there has been an advance in the building of machines, but also in the method of presenting the advantages of the machines to prospective customers. The same holds true of all catalogues and advertising literature of to-day. Years ago it was common for the maker merely to state that he had such and such machines to sell, that they were of accurate workmanship, built of the best materials, and in all ways the most perfect on the market, etc. To-day, while of course these generalities may still be included, we see a large amount of what we may call *specific* advertising, telling exactly what the machine will do and in how short a time it will do it, and what tools are required to perform the operation. Samples of work carried out on the machine are shown, and complete details about turning out the work, the material from which it is made, and so forth, are given. This is the kind of advertising that appeals to mechanical men. To speak in generalities does not appeal to them, because, judging only by general terms, one machine is as good as another; but when the actual facts are given, provided they are given honestly and correctly, a mechanic can judge for himself without hesitation about the merits of the machine. He has some definite data to deal with when making his comparisons. It appears that manufacturers are commencing to appreciate the value of this kind af advertising, because it is becoming more and more common both in catalogues and in trade journal advertisements, to show the work performed, and to give the exact information regarding the performance. It is likely that in the future this class of advertising will be even more common than now, and the mechanical trades will undoubtedly gain by it.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

It is reported that a measure will be introduced at Ottawa for the reconstruction of the collapsed Quebec bridge. The construction work will be in the hands of a board of prominent engineers, and the Canadian government, it appears, is going to undertake the work as a government project.

According to *Indian Industry and Power*, a system of automatic signaling worked entirely by electricity is being installed on the Metropolitan railway in London. The new system provides for applying the brakes to the train automatically if the engineer should pass a signal set at danger.

Superheated steam locomotives appear to be so favorably considered by European railroads that at the present time hardly any express locomotives are ordered without superheaters. Recently 24 express locomotives for the Italian State Railways, built in Germany, were completed, all being furnished with Schmidt superheaters.

Beginning August 3, the last section of the Philadelphia subway was opened for traffic. This subway, which is run in connection with the new Market Street elevated railroad, gives an entire length of rapid transit through the city of about seven miles. The subway construction is of the very highest type, and the approximate cost of the subway portion alone is $20,000,000.

It appears that the authorities of the German State railways have concluded that incandescent gas lighting is superior to electric light in railway cars. No more cars are equipped with electric light, and the engineers, after long and exhaustive tests, have satisfied themselves of the value of the former system of car lighting, and are now changing over the equipment at the rate of 500 to 600 lights a day.

The British Admiralty has decided that in the future all small naval craft shall be constructed to use both coal and oil fuel. The oil-burning system has been used for a considerable time, and many of the destroyers and torpedo boats are designed exclusively for the oil-burning system. All the modern battleships and cruisers of the navy are also constructed to use either coal or oil.

During the year ending June 30, 1908, 1,506 vessels, with an aggregate tonnage of 588,627 gross tons were built in the United States. This is, so far, the largest annual output of the ship building yards in this country. The steel vessels built numbered 142, representing 417,167 gross tons, of which 75 were built for the Great Lakes, with an aggregate tonnage of 304,379 tons. The largest steamer on the lakes built during the year was very nearly 8,000 tons.

After several years of thorough testing and experimenting, the officials of the Burlington railroad have come to the conclusion that concrete ties are not satisfactory, and that the best solution of the railroad tie problem at present is to treat wood so that it will not deteriorate as rapidly as when in its natural state. According to the *Scientific American* it has been decided to construct a large plant for treating ties, bridge timbers, etc., with creosote.

In the May issue of MACHINERY, we mentioned that Professor Kammerlingh-Onnes, a Dutch scientist, had succeeded in solidifying helium. This statement, however, as we mentioned in a later issue, depended on a mistake made by Professor Onnes, he having been deceived by impurities in the helium. He has now, however, announced that he has been able to produce helium in a liquid state, boiling at a temperature of 7.75 degrees F. above absolute zero. He was not able, however, to solidify the liquid.

In a recent issue of the *English Mechanic and World of Science*, it is stated that at the June 15 meeting of the Academy of Science, Mr. Devaux Charbonnel gave particulars of a method of photographing sounds of the human voice, in such a manner that the photographic record could be read. Vowels and consonants are combined by means of the Blondel oscillograph. This extremely sensitive instrument impresses the sounds upon a photographic plate in the form of curves, which can, with a little practice, be easily deciphered.

According to the *Far Eastern Review*, a Chinese gentleman named Hu Chuen has obtained a patent on an improved method of wireless telegraphy, simplifying the methods hitherto in use. The system has been recommended by Chinese authorities for the reason that it makes use only of domestic Chinese materials of lower cost than imported articles, and it is also simpler to operate. At the test of the equipment at Canton it was pronounced a success. Detailed information as to the workings of the new system, however, are not as yet at hand.

The Society of German Engineers, at its annual convention held in Dresden June 29 and 30, and July 1, empowered its officers to negotiate with representatives of the Prussian State government, as well as the government of the German Federation, to make arrangements for the bringing out of the Technolexikon, which, as we have mentioned before in MACHINERY, the society found itself forced to give up about a year ago, on account of the great scope of the work, involving expenditures greater than the society considered that it could consistently make.

The much-advertised New York-Paris automobile race, which started from New York, over a route across the United States, Siberia, Russia, and Germany, to Paris on February 12, this year, was practically concluded by the arrival of the Thomas car in Paris on July 30. This race marks one of the most interesting events in the automobile history, and the fact that it was carried to a conclusion indicates the present state of the endurance of the automobile, and rather reverses the general opinion that the automobile is fit only for good and smooth roads in a country where the repair shop is near at hand.

It is interesting to note that the slide rule, which but lately has become universally used for calculations, was invented nearly 300 years ago. An article in *Zeitschrift für Vermessungswesen* calls attention to the fact that Gunter, shortly after his bringing out the trigonometric logarithm tables in 1620, placed logarithmic scales on wooden rules, and used a pair of dividers to add or subtract the logarithms. In 1627 these logarithmic scales were drawn by Wingate on two separate wooden rules, sliding against each other, so as to render the use of dividers unnecessary, and in 1657, or over 250 years ago, Partridge brought out the slide rule in its present form.

In view of the present agitation for the preservation of the natural resources of the United States, the methods employed by the Swedish government for the preservation of forest reserves as well as ore deposits are of special interest, and we have previously referred to the replanting of forests, the limitation of export shipments of iron ore, and the taking over of some iron ore deposits by the government. It is now reported that the Swedish government is still further pursuing the policy of actual ownership of ore deposits, the present parliament having passed a bill providing for the state purchase of the important Svappavaara ore fields in the northern part of the country.

In an editorial in *Teknisk Tidskrift*, attention is called to the mistaken idea of economy which manifests itself in the

use of cheap materials and cheap labor, rather than in a proper systematizing for using the given opportunities in the most economical way. Many a man thinks that when he can buy some belting for a few dollars less than he has been used to do, by selecting a secondary quality, he has accomplished a great saving, but loses sight of the fact that this mere temporary saving may be lost many times over, through frequency of repairs, faster wear, and disturbances in the running of the shop machinery. Still more serious, however, is the case when the "saver" selects the living material as the proper territory for his exploitation. The expression "cheap labor" is not clear, and it often is the cause of serious mistakes. It is self-evident, says the editorial referred to, that a poorly paid employe, as a rule, does not develop full energy, and that an efficient draftsman, for instance, if he is paid less than the common standard of wages for his class, will constantly give greater interest to the question, "How can I get out of here?" than to the problems which he is supposed to solve.

In an article in the *Engineer*, London, Mr. P. V. Vernon states that a good rule for the horse-power required to drive machine tools is to assume one horse-power for each 10,000 square inches of belt delivered to the machine per minute. This rule is based on a working belt pull of 39.6 pounds per inch of width tending to rotate the pulley, a rule which, it is stated, is justified by the author's experience, and which may be demonstrated as follows: 10,000 square inches of belt per minute = 10,000 linear inches of belt one inch wide per minute = 10,000 ÷ 12 linear feet of belt one inch wide per minute. As each inch of width of belt is assumed to carry 39.6 pounds of effective tension, the power transmitted will be:

$$\frac{10,000}{12} \times 39.6 \text{ foot-pounds} = 33,000 \text{ foot-pounds},$$

$$\text{or H.P.} = \frac{\pi D W n}{10,000},$$

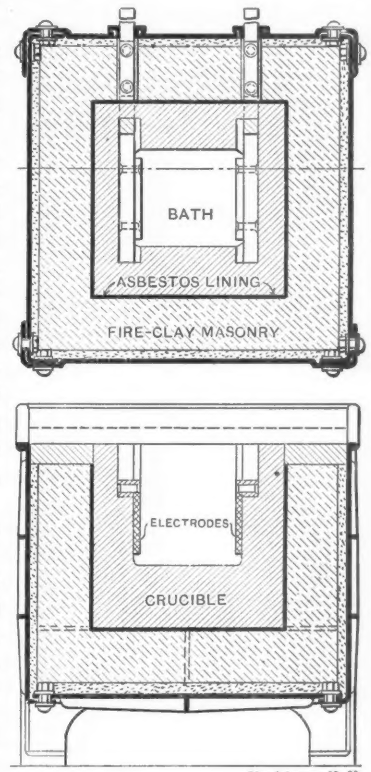
in which formula, D = diameter of pulley in inches,
W = width of belt in inches, and
n = revolutions of pulley per minute.

A tight double belt may transmit twice the amount of power given by the above rule; but although the machine must be strong enough to resist the extra pull, yet it is not wise to provide for double the motive power where a separate motor is used, as most motors will stand as much temporary overload as a belt, and no belt will work well with a permanent overload.

A method for surface-hardening structural steel and steel rails is described in the *Mechanical Engineer*. The principle whereby this is accomplished is as follows: The steel ingot, when stripped from the mold, is enclosed in a receptacle lined with brick, the receptacle being about eight or ten inches larger than the ingot placed in it. Space is left between the ingot and the sides of the chamber, and when the ingot has been lowered centrally into the receptacle, the intervening space between the hot ingot and the sides of the receptacle is filled as rapidly as possible with dry powdered carbon or other carbonaceous material. This material is rammed in between the ingot and the walls, and when the receptacle is completely filled, the ingot is allowed to remain covered for a length of time depending on the amount of carbon to be absorbed by the surface. Several hours, as a rule, is necessary for obtaining the required results. The carbon penetrates into the surface of the steel ingot, and the whole process may be compared with the case-hardening of mild steel parts. The carburized ingot, when removed from the receptacle, is again heated and rolled into a structural shape, the finished article now presenting a hardened surface. It is stated that if it is desirable that only a part of the outer surface of the ingot should be hardened, so that when rolled down, the harder part may form the head of a steel rail, for instance, the part forming a web or flange still remaining soft, the hot ingot may be put into a receptacle, and suitable division pieces inserted so that carbon may be brought into contact only with the part required to be hardened. This process has been developed by Mr. Benjamin Talbot, formerly of Phoenixville, Pa., who is now living in England.

ELECTRICALLY HEATED HARDENING BATHS.

In an article in *Page's Weekly*, the method of hardening small cutting tools adopted by the firm of Ludwig Loewe & Co., in their Berlin works, is referred to. The hardening process is carried on by means of electrically heated barium salt baths, the arrangement of the crucible and the electrodes being as shown in the accompanying engraving. By means of this process, it has been possible to harden large milling cutters in about half an hour, including the time for pre-heating, which takes the greatest part of the time. To bring the cutters up to a temperature of 750 degrees F. constitutes this pre-heating. After that, it takes only about a minute to bring an average-sized cutter to 1,400 or 1,500 degrees F., and then another minute to bring it up to about 2,370 degrees F., which is, by this firm, considered the right hardening temperature. The time stated above refers to average-sized and heavy milling cutters, whereas it only takes from 6 to 10 minutes to bring a small milling cutter to the right temperature in the electrically heated salt bath.



Arrangement of Crucible and Electrodes for Electrically Heated Hardening Baths.

The advantage of electrically heated salt baths is stated as being the total absence of any scale on the tool thus hardened, and that the tools are not distorted in the hardening process. The bright appearance is retained by the hardened tool, so that it is sometimes difficult to tell from the appearance whether a tool has been hardened or not.

In regard to cooling the cutters, the firm of Ludwig Loewe has found that when high-speed steel tools are cooled in an air blast, any moisture coming in contact with the hot tool has a tendency to crack it, so that it becomes necessary to dry the air before it enters into the nozzles. It has also been found that it is absolutely impossible to cool a cutter which has a very heavy body and fine teeth in the air blast, as the heat from the central portion is not extracted fast enough, and therefore does not permit a sufficiently rapid cooling of the teeth to insure proper hardening. For this reason, the firm has adopted a method of cooling the cutters from the hardening heat of 2,370 degrees F. to a temperature of about 1,100 degrees F. by quenching in an electrically heated salt bath. After having been cooled to about 1,100 degrees F. in the bath, the cutters are allowed to cool down slowly in the air, and the whole process has the advantage of being cheap and reliable, as well as effecting a considerable saving in time.

It must, however, be understood that electrically heated barium salt baths are advantageous to use only when a large quantity of tools is to be hardened, because this method will otherwise prove expensive. It has also been remarked that the electrically heated bath is more advantageous for heavy than for small tools but it is not clear why the process should be thus limited to the former class of tools.

A NEW SYSTEM OF WELDING.

Engineering, June 19, 1908.

On account of the high price of high-speed steel, its use, particularly for heavy tools, has been rather limited in the past. All kinds of devices in the form of tool-holders have been adopted whereby a small tool made of high-speed steel performs the cutting, while the remainder of the tool, or the holder, is of cheaper material. Many attempts have been

made to weld high-speed steel onto mild steel, as well as onto high carbon steel, in order that a superior cutting edge may be presented to the work, while the cost of the tool is still kept down to a reasonable figure, the required size and stiffness of the tool being provided for by the body of cheaper material. All attempts to weld high-speed steel onto high carbon steel or machine steel have, however, until quite recently, proved futile. This is apparently due to the different coefficients of expansion of the different steels, high-speed steel having a low coefficient of expansion.

Lately a welding process, however, has been invented which is controlled by the Fusion Welded Metals Co., Ltd., 56 Victoria St., Westminster, London, by means of which it is possible to weld high-speed steel onto other steels. The operations are very simple. The welding of the two steels is performed by means of a thin film of copper. The copper is placed in the form of a feeder along the line of the joint. The parts to be welded are then surrounded by a reducing compound and are placed in a furnace where the temperature is raised to about 2,200 degrees F. The gas which is formed by the burning of the compound seems to affect the copper in such a way that the latter is reduced to a fluid as thin as spirits of wine, and in this condition it penetrates the molecular surfaces of the two classes of steel and produces actual cohesion and not merely adhesion. In fact, the weld becomes stronger than the remainder of the metal, so that if the two pieces being welded are forced apart, the line of fracture will follow the course of a new break rather than pass through the joint. The weld is so close that in some cases it is hardly possible to find a trace of the copper. A wide field of usefulness is predicted for this process. One application which has already been suggested, and where the process most likely will be most commonly used, is that of welding high-speed steel to carbon or machine steel bodies for the production of high-speed cutting tools at a moderate price.

A YEAR'S EXPERIENCE WITH A SUCTION GAS POWER PLANT.

J. C. Miller, in *Power and the Engineer*, May 26, 1908.

The author, in this article, presents the results of a year's operation of a suction gas power plant, stating the fixed charges in a way that will satisfy men who are prone to think of interest, depreciation, etc., as important elements in power cost. The engine under consideration was a single cylinder, horizontal 50 brake-horse-power, regulated on the hit-and-miss principle, and belted to the line-shaft. The gas was drawn from a suction producer, using anthracite pea coal. The plant was of English manufacture, and was well designed and constructed. The producer was equipped with the usual vaporizing apparatus for supplying steam to the blast, and with the usual coke scrubber and expansion box. The cost of the installation of the plant was $3,300. The table below gives the fixed and operating charges:

FIXED CHARGES.	
Interest at 6 per cent	$198.00
Depreciation, repairs, taxes, insurance, 12 per cent	396.00
	$594.00
OPERATING CHARGES.	
Engineer at $2 daily, 300 days	$600.00
67¾ tons coal at $4.50	304.87
Oil and waste	48.00
Scrubber water	12.00
	$964.87
Total yearly charge	$1,558.87
Cost per horse-power-year of 3,000 hours, assuming an average rate of 50 horse-power	$31.17

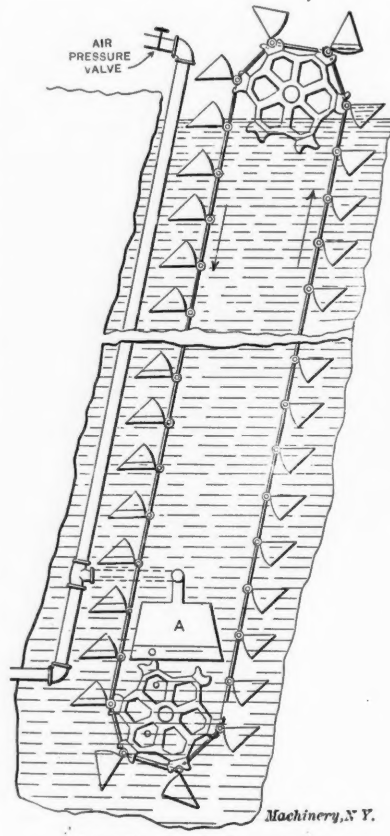
The repairs of the year were relatively small, consisting of new grate-bars in the producer, new coke in the scrubber, and small repairs to the connecting-rod and ignition equipment. The total cost of the repairs, in fact, was less than $10. In the fixed charges given above, 12 per cent has been allowed for depreciation, repairs, insurance and taxes, which was more than ample for the year in question. The cooling water was used over and over, and therefore no charge is made for this item. In the item of attendance, the entire salary of the engineer is charged up against the plant, although he had ample time for other work, but little of his time being needed with the producer and engine after the plant was in operation. The coal used came from the Scranton district and cost $4.50 per ton, delivered. The coal consumed averaged 441 pounds per working day, so that it can safely be said that the consumption was only one pound per brake-horse-power.

The writer sums up by stating his conviction that only hydraulic power can surpass the present showing for economy. The cost as shown, corresponds with electric power delivered to the consumers at 1 1/3 cent per K. W., much below the lowest commercial rate to consumers using an equal amount of power.

NEW IDEA IN AIR COMPRESSION.

Joseph H. Hart, in *The Mining World*, July 25 1908.

The accompanying illustration shows a system of air compression which may become useful under certain circumstances. In the engraving, merely the principle is shown, some mechanical improvements being possible of introduction in a commercial apparatus not being indicated. The construction of this device is very simple. It consists of an endless chain of buckets moving over two cog-wheels, the apparatus being almost entirely sunk under water. The buckets on the left-hand side turn their openings downward when moving in the downward direction, and are thus filled with air when they strike the surface of the water. During the downward movement of the buckets the air inside of them is compressed, as indicated by the double lines on the lower buckets on the left-hand side, the pressure on the air depending simply on the depth of the buckets below the surface of the water. When the bucket comes to the lower cog-wheel, it is turned around and the air escapes, being then collected into a hood *A* where it will be under pressure corresponding to the hydrostatic pressure of the water at the point at this depth below the surface. At the top of the mechanism the water is carried from the surface to the upper level of the wheel, and when the buckets are reversed, the water is dumped, and the buckets again filled with air. The raising of the water from the surface to the place where it leaves the buckets represents one of the losses of the mechanism. This loss remains approximately constant for all conditions, and expressed as a percentage of the total power required, it decreases as the depth of the device, and in consequence the compression, increases.



New Idea in Air Compression.

EDISON MONOLITHIC CONCRETE HOUSES.

Several months ago Mr. Thomas A. Edison aroused considerable interest in a proposed monolithic concrete construction for dwelling houses, the details of which he has worked out. The idea briefly is to mold a house complete, the same as an iron casting is made in sand, with the difference that in the Edison house scheme the mold is constructed of cast-iron forms, which are set up to make the house complete, even including the roof, porches, steps and everything required to complete a dwelling house. Mr. Edison had calculated that a workingman's two-family dwelling house of one-piece

concrete could be made in this manner for about $1,200; but, like many other schemes that appear promising on the face, this one does not appear as promising upon investigation.

In the first place, the cost of the cast-iron molds for a two-family house would be not less than $25,000, according to Mr. Edison's own estimate, and the weight would be not less than 280,000 pounds. This, of course, means a very large initial investment and costly transportation of the molds from one building site to another. The size of the dwelling proposed to be built in this manner is 21 feet by 49 feet, with a height of 35 feet, not including the cellar. The walls will be 12 inches thick, decreasing to 8 inches on the second story. The roof is to be 6 inches thick, and the floors and partitions are 4 inches in thickness throughout. The structure will be reinforced with ½-inch and ⅝-inch steel rods. Water pipes, gas pipes, plumbing, ducts for wiring, and lining for chimney flues are set in position before pouring the concrete.

The concrete mixture proposed is one part cement, three parts fine sand, and five parts stone or gravel, fine enough to pass through a one-half inch sieve. In order to prevent segregation of the materials before reaching their destined position in the molds, it is proposed to add colloids, which, in common language, are certain clays that promote fluidity of the concrete and non-segregation of the constituents.

The scheme undoubtedly would prove unprofitable except where large numbers of houses were built on one plot and where the materials could be obtained at low cost. The investigation made by a disinterested expert appears to indicate that Mr. Edison's estimate of the weight of the molds and the cost of houses built in this way is too low. The cost of a house, with the present prices of labor and material, would be nearly twice the figure quoted, according to the *Cement Age*, and the weight of the molds would be considerably greater than 280,000 pounds.

The future of monolithic concrete construction for houses, factories and other structures depends very largely on the means developed for holding the materials in place during the setting period. It appears that the Edison plan is crude and very costly. The ultimate development of cheap concrete construction of the monolithic type would appear to require a combination of wooden forms and cast-iron molds made up so that a large variety of shapes can be produced with comparatively few forms.

CALCULATIONS FOR MAGNETIC CLUTCHES.

Engineering Digest, June, 1908.

The author of the article here abstracted presents the following formula for calculating the number of ampere turns of excitation required for an ordinary magnetic clutch, consisting of a thick disk with an annular space machined out of one face for the magnetizing coil, and provided with a flat-faced disk armature of the same diameter.

$$\text{Ampere turns} = \frac{9{,}500{,}000\ LBD\ \sqrt{H.P.}}{A\mu\ \sqrt{BN(D^2 + 8\,RB)}}$$

In this equation,

L = mean length of the magnetic circuit,
B = radial width of the annular pole face,
D = diameter of central pole face or hub of clutch,
$H.P.$ = brake-horse-power to be transmitted.
A = mean cross-sectional area of the path of the lines of force,
μ = permeability of metal, say 2,500 for wrought iron,
N = revolutions per minute,
R = mean radius of annular pole face, which, in turn,

$$= \frac{\text{outside diameter of clutch} - B}{2}$$

All dimensions are in inches.

As an example, assuming that $R = 4$ inches, $D = 2\frac{1}{2}$ inches, $B = 1$ inch, $L = 10$ inches, $A = 9$ square inches, $H.P. = 4$, $N = 100$, and $\mu = 2{,}500$, then the ampere turns equal

$$\frac{9{,}500{,}000 \times 10 \times 1 \times 2.5 \times \sqrt{4}}{9 \times 2{,}500 \times \sqrt{1 \times 100(2.5^2 + 8 \times 4 \times 1)}} = 340$$

To allow for the reluctance of the joint, this should be increased to, say, 400.

CASTING PIPES IN PERMANENT MOLDS.

Paper read by Edgar A. Custer before the Franklin Institute, March 26, 1908.

A great deal of experimenting has been undertaken in the past in order to determine the requirements for permanent molds for making castings; that is, molds which could be used over and over again for producing the same parts. The purpose of the present discussion is to describe a method and apparatus using permanent molds which are not destroyed through the action of the hot iron, and in which cast iron pipe can be produced in which the supposed evils of unequal heating and cooling due to the use of permanent molds do not appear.

So-called permanent molds are not new. For many years, small iron castings have been successfully made in iron molds without great detriment to either casting or mold. These castings, however, have invariably been very small, and the process chilled them to extreme hardness, so that it was not possible to machine them. This limited the use of such molds very materially. Extensive experiments, however, have been undertaken by the Tacony Iron Co., Philadelphia, Pa., for producing cast iron water and gas pipe in permanent molds.

The ordinary process for casting such pipe is as follows: Iron flasks, a cope and drag, are rammed with sand over a metal pattern; a green sand core is introduced, and the cope and drag are clamped together. The pipe is then poured,

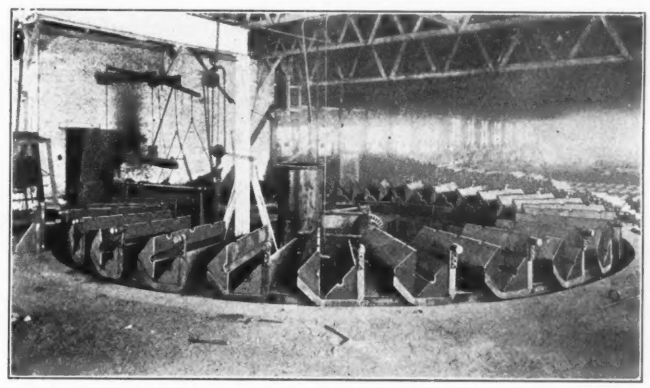


Fig. 1. General View of Machine for Casting Pipe in Permanent Molds.

with the pipe in a horizontal position, and after cooling, the pipe is removed from the flask and carried to the end of the floor where the cores are removed. Then it is carried to the cleaning room where the sand is rattled off, the gates and fins are removed, and after inspection it is ready for shipment. Altogether the pipe has to be handled ten times. In this process the loss is great, often reaching 12 to 15 per cent. In fact, with very few improvements, and these relating mainly to cores, soil pipe is made in precisely the same manner and with just as much labor per pipe as was the practice fifty years ago.

Any process that would save the use of sand for the mold, and would produce pipe that could be easily cut, would naturally be very desirable. In addition, if it would be possible to produce a machine so that the work could be carried on continuously day and night, it would evidently be of great advantage for economical production. The experiments undertaken by the firm previously referred to made it possible to design a machine which would operate continuously, using permanent molds. These experiments showed that when pipes were cast in a mold every eight minutes, the temperature of the mold never raised above 450 degrees F., even if the operations were continued for hours. If, however, pipes were poured every two minutes, the temperature of the mold would rise rapidly, and at 900 degrees F. it would begin to warp. In order to comply with the requirements thus determined, the machine as described in the following was designed.

Machine for Continuous Casting of Pipes.

The machine consists of an angular table or ring approximately 40 feet in diameter, which carries 30 molds arranged at equal intervals. The table is constructed of two concentric rings of channel beams connected with 30 cross pieces or trucks, each of which has two wheels with roller bearings to

support the frame. The wheels run on concentric circular tracks laid in concrete foundations. The tracks are arranged on an inclining conical surface, and by this means the table will resist any movement other than rotating about its center.

Each truck or cross bar of the table carries a steel pin working loosely in a vertical hole and of such length as to allow about two inches of the pin to project below the bottom line of the truck, but admitting it of being pushed up until flush with the bottom of the truck. Under the table or ring, at two diametrically opposite points, are arranged two hydraulic cylinders which slide in ways similar to those of a planer, the pistons within the cylinders being held stationary, and the cylinders moved back and forth by the operation of a four-way valve controlling the admission of water alternately to each end of the cylinders. The stroke of the cylinders is of such length as to be slightly more than the spacing of the molds carried by the table. Projecting from the top of the cylinder is an inclined plane surface designed to lift the truck-pins, previously referred to, when the cylinders move in a direction opposite to the required motion of the table, and to allow a pin on each side to fall, after the inclined surface has passed. This occurs at or near the end of the backward stroke of the cylinders; and when the controlling valve is so

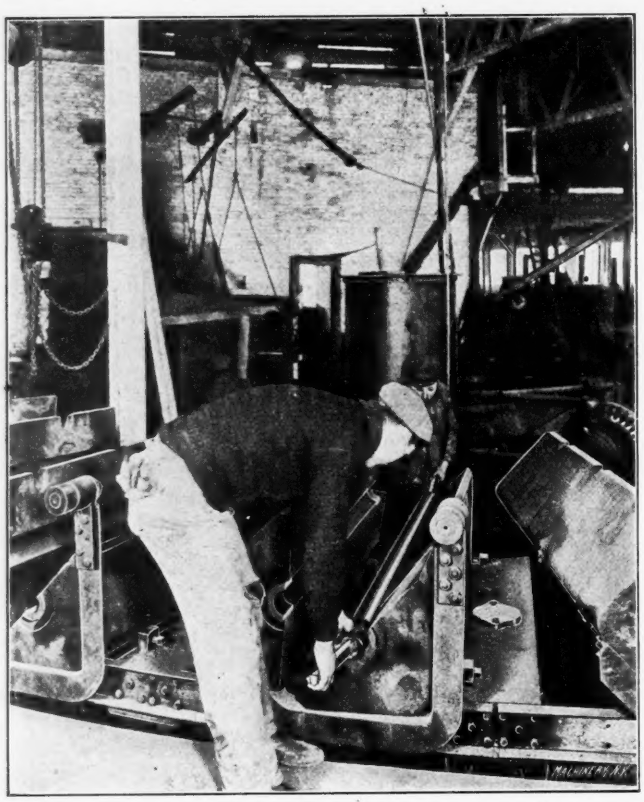


Fig. 2. Setting the Core.

moved as to cause the cylinders to move forward, the pins which have been lifted and allowed to fall are brought in contact with the projections on the cylinders, and hence the table is carried forward by the motion of the cylinders a distance equal to the spacing of the molds, and the cylinders are ready for another return or back stroke to engage the next pins, thus intermittently moving the table ahead one space at each cycle of the cylinders.

The center of the table is left open for the location of hydraulic pumps, operating valve reservoirs, etc., required in imparting motion to the table. The table makes one complete revolution every seven and one-half minutes, and consequently produces thirty pipes in that time, or two hundred and forty pipes an hour.

At certain points about the table are arranged closing and opening devices, which are designed to close the mold, or bring the cope side down to its place on the drag side, without shock, after the cores are set in place, and to open the mold or lift the cope after the pipe has been poured.

Between the closing device and the opening device is located a pouring device adapted to receive the molten metal from the cupola and pour it into the molds.

Description of Mold.

Each mold consists of a rectangular block of cast iron, approximately 18 inches wide and 18 inches high, by 6 feet long, parted on a diagonal line across the corners, and provided with hinges at the lower edge of the parting so as to allow the upper portion or cope to be swung up and back from the lower portion or drag. These molds weigh about 6,500 pounds complete. At the center of the mold is the cavity into which

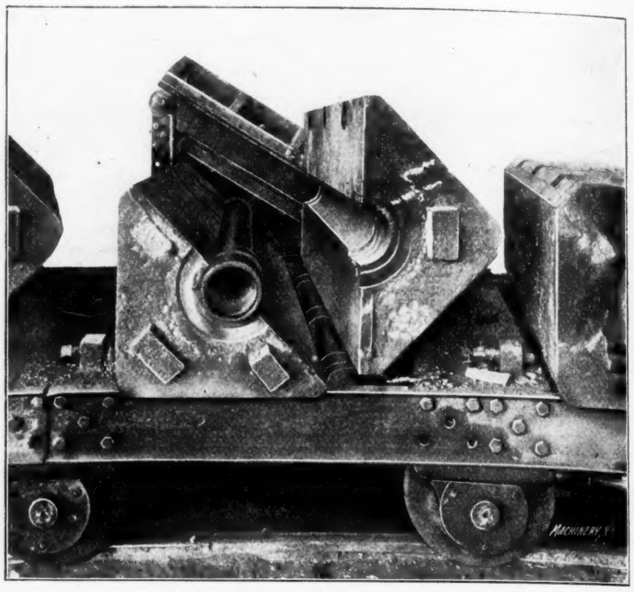


Fig. 3. Mold entering Closing Device.

the metal is to be poured to form the pipe. Thus one-half of the pipe is formed in the upper and one-half in the lower portion of the mold.

Gates are cut in the face portion of the lower part or drag, of such size and shape as to receive the molten metal from the ladle and guide it into the mold. Three such gates are used, each dividing into two portions. Thus the cavity of the mold is entered at six points. The gates are so shaped as to receive the shock of the falling stream of molten metal at a point outside of the mold cavity, and convey it into the mold quickly but gently, so that the core is not damaged by a rush of molten metal against it. At the highest point of the barrel of the mold, a small groove is cut, extending through-

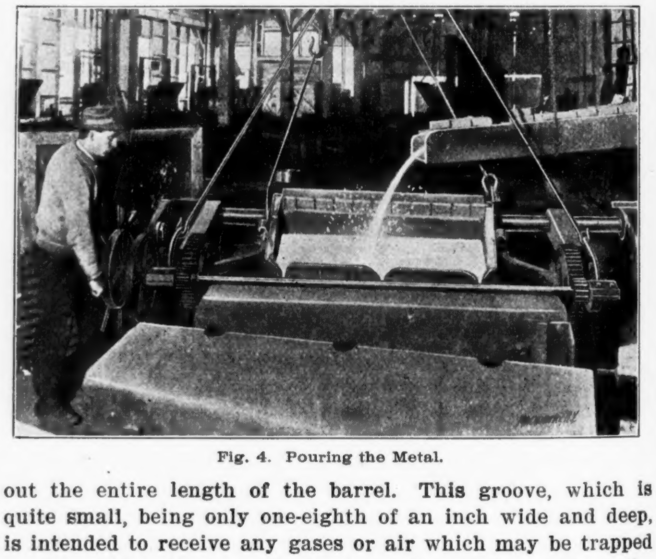


Fig. 4. Pouring the Metal.

out the entire length of the barrel. This groove, which is quite small, being only one-eighth of an inch wide and deep, is intended to receive any gases or air which may be trapped in the mold, and so avoid the formation of flat spots at the top of the pipe. The resultant ridge not being prominent is not an objection, but rather adds to the strength of the structure.

On one end of each mold is carried an arm rigidly attached to the upper or movable half. This arm extends under the mold, and is of such form that when the mold is open it forms a rest for the movable half, holding it in such position as to allow of any work, such as setting cores, removing finished pipes, cleaning, etc. On the end of this arm is a steel roller

which is caused to travel down an inclined plane by the rotation of a table carrying the mold. This inclined plane is arranged to receive the roller at its higher position when the mold is open, and to guide it smoothly to its lower position, by this means closing the mold without shock or jar to disturb the core. This inclined plane constitutes the closing device. Each end of the mold is provided with rings or bushings which are used to support the core arbor in a precisely central position in the cavity of the mold, so that the pipe when finished shall have uniform thickness of metal at every point.

The core arbor consists of a cast iron hollow cylinder somewhat longer than the pipe to be cast and about three-quarters of an inch less in diameter than the inside diameter of the pipe. It is perforated throughout most of its length by small holes to allow any gases formed by contact with the molten metal to pass into the arbor and so have free vent to the air through the ends.

The core is made by placing the core arbor in the core machine, which consists of a support for the ends of the arbor, semicircular in form, and of a diameter to fit the arbor ends,

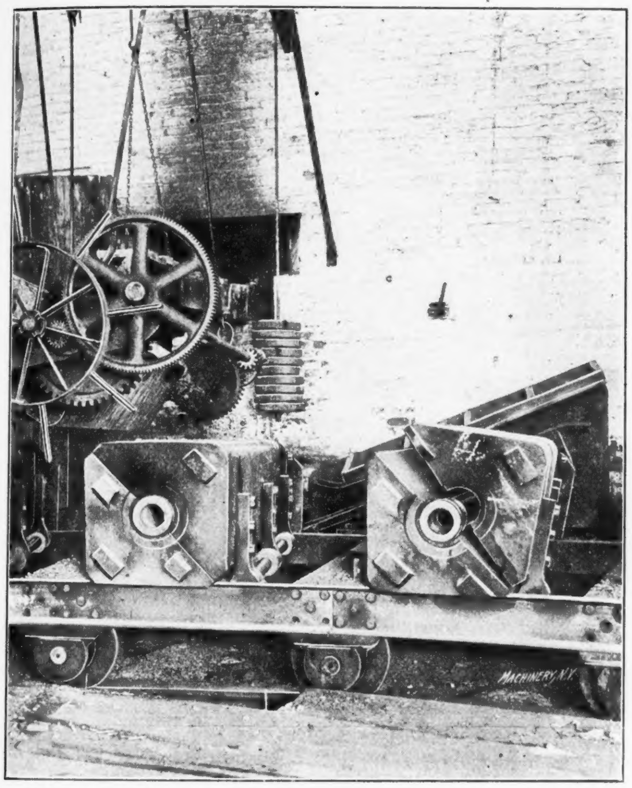


Fig. 5. Immediately after Pouring. Mold, entering Opening Device, partially opened.

a shaking screen arranged to sift sand, and a guide to drop it upon the arbor, and a knife, so shaped as to form the sand to the outline of the inside of the pipe.

The core arbor, after being thoroughly wet, is placed in the end supports and rotated by a crank-shaped piece of iron held loosely in one end by an operator. At the same time another operator shakes a sieve suspended over the arbor and previously filled with sand, saturated to the proper degree with water. This sieved sand is caused to fall directly upon the wet, rotating arbor and clings to it. The surplus sand is scraped away by a steel knife held at the proper distance from the arbor to make the finished core of the diameter and shape required. When sufficient sand is on the arbor to make a full and complete core (which requires about five seconds), the core is lifted from its supports and is ready for use. No further treatment of any kind is needed, and the core is placed in position in the mold, which is then caused to pass the closing device, bringing the upper portion down in place, and the mold is ready to receive the metal.

A ladle is provided to receive the metal as it flows from the cupola. As the table rotates and brings a mold, which has passed the closing device, into pouring position, the ladle automatically drops into position with the lips close to the pouring holes. The ladle is then tilted to pour by the operator, but in tilting it rotates around a center line which passes through the pouring lips, and hence the points of pouring do not move; and the streams of metal are guided directly from the pouring holes through the various gates into the mold, and fill it completely, compressing any air or gas which may be trapped into the groove provided at the highest point for that purpose. If no gases are trapped, which, strange as it may seem, is usually the case, this groove is also filled with

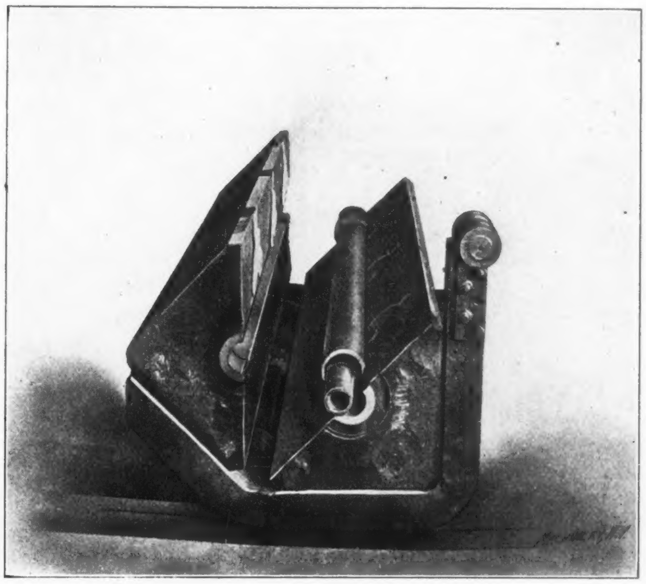


Fig. 6. Mold open. Pipe Cast in Place.

metal and forms a slight rib running the length of the pipe. When the pouring operation is complete and the operator tilts the ladle back, it automatically rises to a higher position, so that the next mold may pass under it and assume the pouring position.

The mold being now filled with metal, is held long enough to allow the metal to set, and is then opened by passing the opening device, which is just the reverse of the closing device, the roller on the end of the arm or mold being guided up an inclined plane, thereby lifting the upper half or cope side, and swinging it away from the lower or drag side. The pipe,

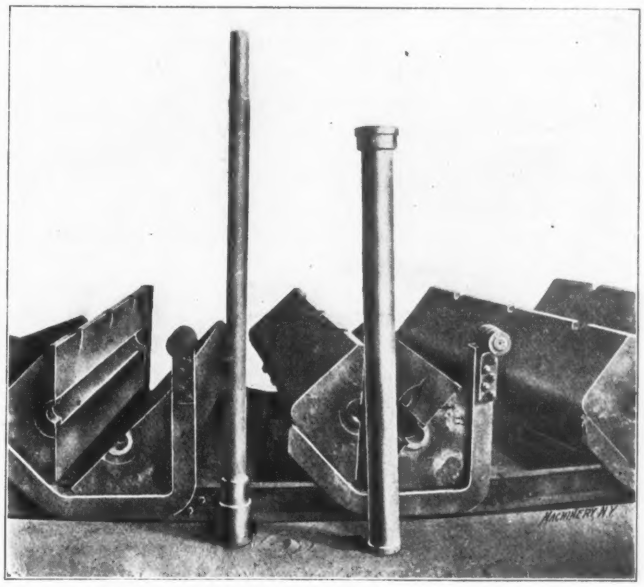


Fig. 7. Finished Pipe and Arbor. Molds Open.

which is still a bright orange color, is lifted from the mold and placed, after removal of the gates, with those previously cast, in piles, to cool slowly, when the core arbor is withdrawn and returned to the core machines to be used again. After removal of the finished pipe from the mold, the loose sand which falls from the core during the handling of the pipe, and any other dirt, loose gates, etc., which may be left in the mold are swept out by air blasts or hand brushes, and the mold is ready for another core and another filling with metal.

LOCK NUTS USED IN ENGINEERING PRACTICE.

R. B. LITTLE.*

A great variety of different means have been devised for locking a nut in place, so as to prevent accidental loosening of the parts being held together by the tightening of a nut on its bolt. In the accompanying Supplement are shown twenty-seven different styles of locking arrangements, care having been taken to select those that are most commonly found in engineering practice. It is not necessary to explain all of the methods indicated at length; a few words relating to each type will suffice. Referring to the Supplement, Fig. 1 shows a locking device where the nut is locked to the bolt by means of a set-screw. A small plug of steel or brass is placed in front of the screw point, to prevent the screw from injuring the thread of the bolt.

Fig. 2 represents the U. S. Navy standard form of lock nut. It will be noticed that the first shoulder below the nut proper fits in the stock, while the second one is smaller and acts as a face for the set-screw to engage with. Also note that the set-screw is "dog-pointed," and that the nut proper never should come down flush against the stock; 1/32 inch clearance is allowed here for all sizes of nuts.

Fig. 3 shows a very good form. A shoulder is turned down on the lower side of the nut to the diameter across flats, and a groove is turned in this shoulder for the point of the set-screw. A collar fitting this shoulder is fastened by a pin as shown. A set-screw is then passed through this collar and engages in the groove of the nut. The thickness of the collar and shoulder should be about one-quarter the diameter of the nut plus ¼ inch, in good practice, and the pin which holds the collar should be one-eighth the diameter of the bolt plus 1/16 inch.

In the method shown in Fig. 4, a special nut with a slotted flange is required. This flange has six slots, and the dog which acts as a check is provided with an oblong slot. This arrangement gives a positive lock, and the nut can be locked at any position required. The thickness of the dog and the slotted flange should be about one-quarter the diameter of the bolt.

Fig. 5 is an excellent form. It is a combination of the spring and double nut arrangements shown in Figs. 10 and 11. The double nut may work loose under constant rattle and jar, but the split ring below has a tendency to absorb the jar. This form is used extensively in automobile frame construction.

In the method shown in Fig. 6, a small taper pin is put half in the nut and half in the bolt, one half-hole being put in the nut and six, or as many as desired, in the bolt. This allows of finer adjustment than one hole only. The taper pin should never be driven in too tight to prevent its being pulled out without difficulty when required.

Fig. 7 requires a specially made nut. It is made of stock one-half the thickness of the nut, which is doubled over on itself, as shown, and afterwards tapped. After this nut is screwed down tight in place, a little extra twist on the top half locks it very securely.

Fig. 8 shows an inner nut which is tapered and split. This inner nut fits in an outer shell which has a tapered hole. When the nut is assembled in place, the screwing down of the outer shell pulls the inner nut down in the taper hole, which closes the split in the side. This clamps the inner nut to the bolt. This form is highly recommended.

Fig. 9 shows the regular slotted or castle nut. When the nut is screwed down in place, a small hole is drilled through the bolt at the bottom of one of the slots, and a cotter pin is inserted.

Fig. 10 shows the old reliable form of nut and check nut, or double nut. The check nut is commonly made one-half the thickness of the nut proper, and should be placed on the under side, as shown. This arrangement puts the stress on the thicker nut, where it should be because of the greater number of threads to receive it.

In Fig. 11 is shown what is known as Grover's spring. When the nut is screwed down tight, the spring is flattened, and its elasticity keeps the nut tight on the bolt.

Fig. 12 shows the ear washer. After the nut is screwed down in place, the ear on the washer is bent up tight against a flat side of the nut, and a small pin keeps it from turning. This washer should be about one-sixth of the diameter of the bolt in thickness.

Fig. 13 shows a right-hand nut below, with a smaller left-hand nut above it, both screwing on the same bolt. All tendency of the larger right-hand nut to unscrew is counteracted by the smaller left-hand nut, which screws on tighter if the larger nut turns.

Fig. 14 shows a regular hexagon nut with a slot sawed a little past the center and about three threads from the top. After this nut is screwed down in place, give the part above the slot a little extra twist, the same as in Fig. 7, or hit it a light tap with a hammer, and spring the shelving part down a trifle. When the nut is to be removed, the top part may be sprung back again to place, and it is then easily unscrewed.

In Fig. 15 the same sawed nut is used as in Fig. 14, and a small screw is placed as shown. After the nut is screwed down, the small screw is tightened. This increases the friction between the threads of the bolt and nut by springing down the upper and thinner part.

Fig. 16 represents the lip washer. This washer has a small lip on the inside which slides in a groove in the side of the bolt. All tendency of the work below the nut to move is spent on the washer which cannot move because of the lip. This is a very good form, and is extensively used.

Fig. 17 shows a small lock fastened down by a cap screw, the flat side of the lock coming against the flat of the nut. In Fig. 18 the principle of locking is practically the same as in Fig. 17, except that the nut may be locked at every one-twelfth turn instead of one-sixth turn. This allows of much finer adjustment. The principle of the form shown in Fig. 19 is the same as in Figs. 17 and 18, except that the lock fits the corner of the nut. The method shown at Fig. 20 is exceptionally good where a circle or long row of nuts are to be locked. Fig. 21 quite closely resembles Fig. 18, except that the nut is locked on all sides. This form also admits of a one-twelfth revolution in locking. The locks shown at Figs. 17, 18, 19, 20, and 21 are known as stop plates.

In Fig. 22 an ordinary bolt and nut are used. The bolt is allowed to stick through the nut a short distance. The end of the bolt is sawed before the nut is screwed on. After the nut is screwed home, the end of the bolt is wedged out a trifle with a dull cold chisel. This locks the nut very securely, but by screwing the nut off, the sawed end of the bolt will be brought back to its original shape.

In Fig. 23 a small cap screw is screwed down so that its head is tangent to a flat side of the bolt. In Fig. 24 a taper pin is driven in firmly as shown, so that it enters partly in a groove in the side of the nut.

Fig. 25 shows an excellent method, but a special nut is required. The nut must have a slotted flange as shown. The small pin shown has a shoulder which comes up under the bottom of the nut, and behind the pin is a coil spring. By pushing this pin down flush with the surface of the work, the nut may be turned to any position desired, and the pin will spring back into place, thus locking the nut.

In Fig. 26 a small hole is drilled through the bolt, flush with the top of the nut. A piece of soft wire is run through the hole and wound around the bolt, as shown, to insure against its coming out. This form also answers very nicely where more than one nut is to be locked. The wire may be passed on through any number of bolts and its ends fastened.

In Fig. 27 a slotted nut is required. A groove is cut down the side of the bolt deep enough to contain a wire. The nut is screwed down with the wire in place in the slot in the bolt, and the wire is then bent over in one of the slots.

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* * *

It is alleged that freight shipped from Cincinnati to Toledo, *via* the Erie and Miami Canal often is received in a shorter time than when sent by rail. This, if true, confirms the statistical average of railway freight movement of only about 25 miles per day, a rate of progress considerably less than that achieved by the canaller traveling by daylight only. A canal boat hauled both day and night can easily make 60 miles per 24 hours.

GAGE FOR TESTING THE PLANING OF A TURRET MACHINE BED.

The large bed casting shown machined and mounted on its supports in Fig. 1, is that of the Libby turret lathe, built by the International Machine Tool Co., of Indianapolis, Ind.* In this machine the head-stock and bed are one solid casting, so that particular care has to be taken in planing and boring to have all parts come to the right dimensions, as the machine is built on the interchangeable plan, and no alterations from the drawings are allowed for the sake of making a faulty casting "finish out." One of the special tools used to place the making of the bed on an interchangeable basis, is the gage shown in place on the ways in Fig. 1. This gage is used for testing the planing of all the sliding surfaces of the casting, in their relation to each other and to the center line of the spindle.

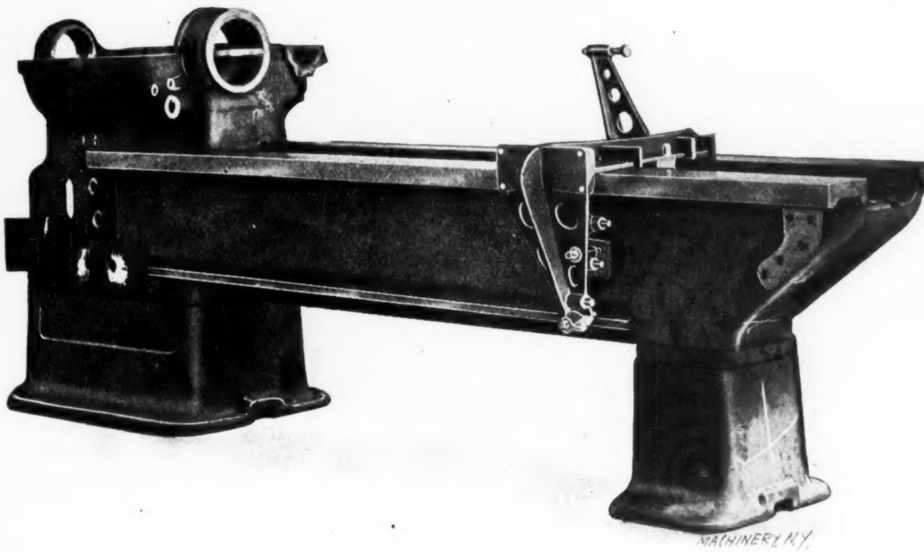


Fig. 1. A One-piece Turret Lathe Head-stock and Bed, with the Gage by which the Planing is Tested; the Center in the Vertical Arm must coincide with the Center Line of the Spindle.

After the casting has been cleaned and made ready for machining, the first operation is naturally that of "laying out." The reference line is the center line of the spindle. It is located in the usual way, by prick-punch marks in cross pieces inserted in the spindle boxes. This center line is so located that the spindle boxes will clean out, the ways finish to the right horizontal and vertical distances from the center line, and all other planed surfaces and bored holes come to the proper dimensions. When this laying out is completed, the bed is placed on the planer table right side up, with the axis of the spindle carefully lined so that it is parallel with the ways of the planer. Roughing cuts are then taken over the top and front edge of the casting at the points marked *A* and *B* in Fig. 2, which shows a cross section of the bed. This operation determines the lay-out of the bed, and if there are any surfaces or holes which do not finish out to dimensions in the subsequent operations, the piece is spoiled.

The casting is next turned over on the planer and mounted on parallels so that the head-stock clears the bed, being clamped on surfaces *B* and *B*, and lined up with surface *A* parallel to the ways of the planer. The base *C* is now planed to the finished dimension. The casting is then again reversed and clamped to the planer platen on this finished surface *C*, with edge *A* lined up with the ways of the table; all subsequent planing operations are completed without further shifting of the work.

The next finishing operation is the surfacing of *A* and *B*. To test this operation, the gage shown on the bed in Fig. 1 is used. The general form of the gage is perhaps more readily seen in the succeeding illustrations, Figs. 3 to 7. It will be seen that it rests on surface *B*, and when in use is aligned by its bearing on the vertical surface *A*, against which it is held by a clamp screw (best seen in Fig. 7) which bears on surface *D*. When these surfaces *A* and *B* are properly finished, and the gage is aligned as described, the center mounted in the upper arm must coincide with the prick-punch mark in the cross piece of the front spindle box, from which the primary lay-out was made.

These gaging surfaces, *A* and *B*, having thus been finished, the next operation is the laying-out of the succeeding cuts. Vertical surfaces *D*, *E* and *F* are located by scribing on the top surface of the bed lines gaged by the corresponding surfaces *D*, *E* and *F* in Fig. 3, these surfaces being carefully machined to the dimensions given on the drawing of the work. *D*, *E* and *F* may now be roughed and finished, the final testing of the accuracy of the work being effected by clamping the gage on the bed in its proper position, and testing the surfaces completed to see if they match up with the corresponding surfaces on the gage.

At *G* in Fig. 2 is the surface to which is fastened, by means of a clamp entering the dove-tail *H*, the casting which carries the series of stops used for limiting the movement of the turret slide. At *G* in Fig. 3 will be seen a hardened plunger, carried by a steel bushing mounted in the gage, and provided with a cross pin, projecting through an L-shaped opening in the bushing. This plunger, which is forced downward by a spring, may be released so that the lower end rests on the surface *G* of Fig. 2. If this surface is properly located, the upper end of the plunger and the upper end of the bushing in which it is contained will be flush with each other, both having ground surfaces. By this means, the accuracy of location of surface *G* is tested. When the plunger is not in use, the operator's finger on the cross pin raises it, and swings it into the horizontal portion of the slot, thus holding it into its upper position. For locating the dove-tail slot, block *H* in Fig. 3 is provided. It may be slipped into a slot on the under side of the gage, and used for scribing the lines used for locating the rectangular groove, which is first planed to the proper depth in the casting. This rectangular groove is then finished out to

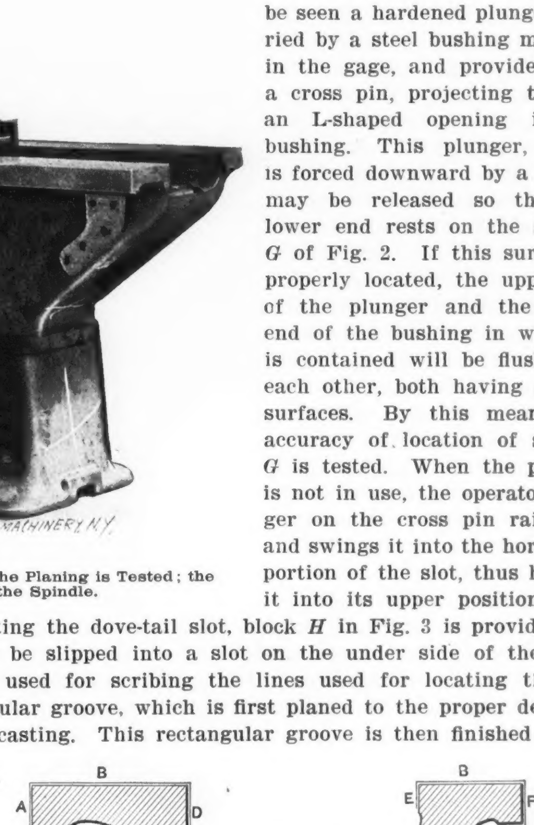


Fig. 2. Cross-section of the Bed; the Surfaces to be Finished are Indicated by Double Lines.

the desired angle on each side by tools held in the swivel head of the planer. The accuracy of the finishing of each side of the slot is gaged by block *H'* in Fig. 3, which, when placed in the dove-tail groove, with the bevel on either side, must accurately enter the same slot in the gage in which block *H* is shown in the figure.

As may be seen in the various illustrations (see Fig 4, for instance) the gage is provided on the front side with an arm which projects downward, and carries the various reference surfaces, gage pins, etc., required for properly testing the

* See the New Machinery and Tools section of the March, 1908, issue of MACHINERY.

machining on the front side of the bed. In the cross and turret slide carriages of this machine, there are three revolving parts which only just clear the rough surface of the bed. These clearances are made small, to reduce the overhang of the carriage as much as possible, so that the operator may get close up to his work. The gage is provided with pivots

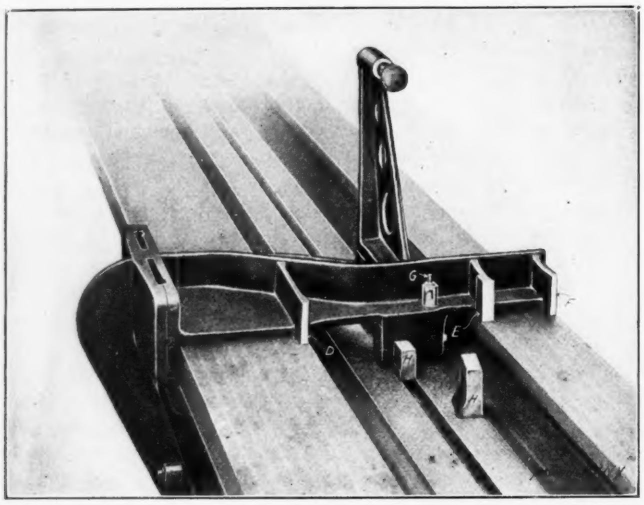


Fig. 3. Block and Gages for Laying Out and Testing the Dove-tail Slot.

I, *I* and *I*, on which may be mounted cast iron disks *J* and *J* (see Fig. 4). When mounted on these pivots, these disks exactly correspond in position and diameter with the revolving parts which have to clear the bed, and if the operator slides the gage from one end of the ways to the other, and these disks clear, he may be sure that in the finished machine the carriage parts will also clear. If they interfere, the casting must be trimmed in the planer. The lower and smaller of the two disks *J*, after being tested in the position shown, is tried again on the middle pin *I*.

As those of our readers who are familiar with this machine know, the cross-slide carriage is mounted on the bed in a very

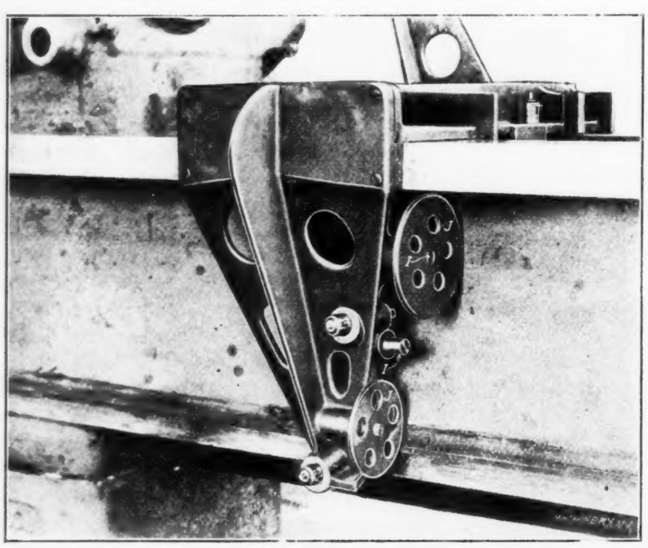


Fig. 4. Testing the Bed for Clearance for Revolving Parts in the Apron.

peculiar way, being supported entirely by surfaces *D*, *B*, *A*, *L* and *M*, in Fig. 2. It does not extend across to the ways on the rear side of the machine. This construction allows the cross slide to clear practically the full diameter of the work capable of being swung over the ways, so that while the work is in place, the slide may be moved clear back past it and the chuck by which it is held, allowing the turret slide to be brought close to the work. It is evident, then, that surfaces *L* and *M* must be finished with reference to surfaces *A*, *B* and *B*. They are gaged as shown in Fig. 5, where a spring plunger *M* is shown, exactly identical in construction with *G* in Fig. 3, which is released from its locked position and forced down by a spring against the surface in question. If this surface is right, the ground end of the plunger and of the bushing contained in it will be flush with each other. To measure surface *L*, an angular face is provided at the lower extremity of the arm, as shown, on which the straightedge *L* in Fig. 5 may be laid. If this accurately lines up with the corresponding surface of the casting, the planing is right in this respect.

There are finished pads on both the front and back sides of the bed, not shown in Fig. 2, which support the various feed and rapid-traverse shafts. These must also be machined to the proper distance horizontally from reference surface *A*. The spring plunger *N*, identical in construction with *M* and *G*, is used for the front surface. This is shown applied to this surface in Fig. 1. For the pads on the rear, a gage *O*, Fig. 6, is used, which, when held as shown against the finished face of the bed, must just make contact with a plug set into the rear end of the fixture.

When all the tests described have thus been made, it may be assumed that the work is correct, so far as the planing is

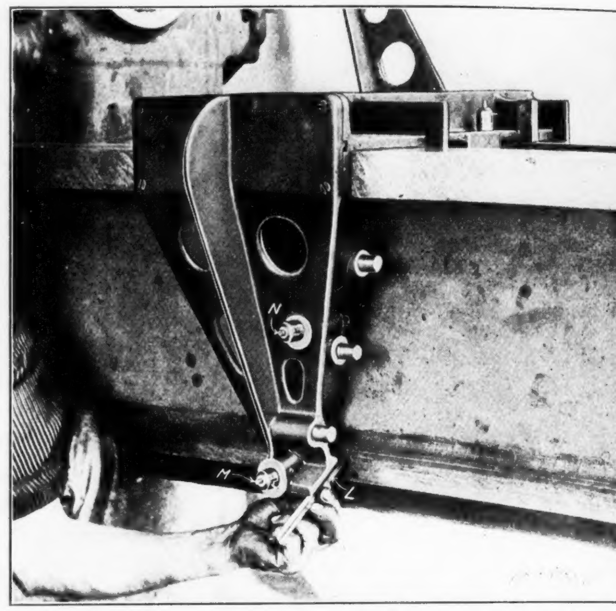


Fig. 5. Testing the Bevel Bearing Surface for the Cross-slide Carriage Support.

concerned. Surfaces *K*, *P* and *Q* are good enough if made to careful scale measurements.

It will be seen that this gage simplifies to a remarkable degree the inspection, the laying out, and machining of these castings. The foreman, for instance, if there is a question about the accuracy of the workmanship in a particular case, can put the gage in place and take all the measurements inside of a very few minutes. It can be imagined that the device under these conditions is a great incentive to accurate work.

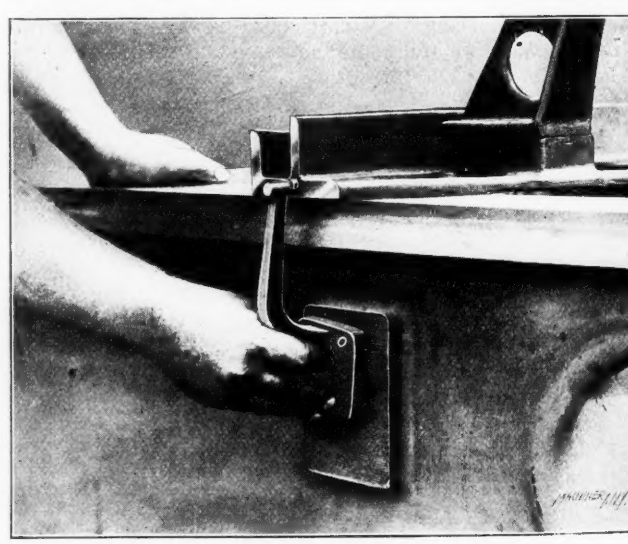


Fig. 6. Testing the Planing of the Pad for the Bracket of the Quick-motion Shaft.

A practical man will readily understand that the advantage of working so closely to figures as is required by a gage of this kind, does not consist in cheapening the actual

cost of the planing or inspection. The cost of planing, in fact, is doubtless increased by its use, owing to the higher grade of workmanship which it requires. The advantage is seen when it comes to assembling and fitting up the machine. The main casting is always the part that is most difficult to build on an interchangeable basis. With the aid of such devices as the one we describe, carrying throughout the whole casting the system of close working to figures, the time of assembling and fitting is greatly reduced. This is what counts, as it saves a large share of the most costly work that goes into the building of a high-grade machine tool.

Fig. 7. The Gage mounted on its Truck, by which it is carried where needed.

The possibility of saving a lot of time in the assembling, at the expense of a comparatively small loss of time in the manufacturing, is one that is not always appreciated.

A tool that is as useful as the one we have just described merits the best of treatment. In Fig. 7 we show the gage as it looks when at home. As may be seen, it is comfortably mounted on a special truck, which may be wheeled from point to point in the shop, as the case may require. The various supplementary devices shown in the preceding illustrations are carried in the box body of the truck. It is certainly encouraging to see a faithful servant so well looked after.

* * *

THE SELF-RELIANCE OF JIM WEST.

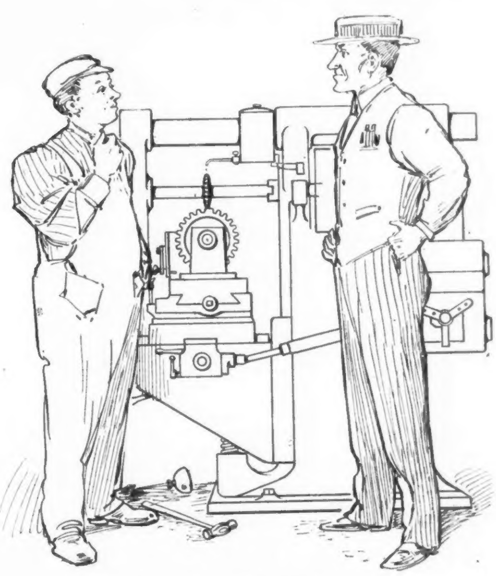
GREBO.

A modicum of self-reliance and self-esteem is a pretty good thing for any man to have, but in the days when a man is very hard up for a job, it has occurred that his estimate of his own ability has been somewhat above par with results disastrous to his self-esteem and reputation.

Some years ago Jim West concluded that the only way to get a job was to put up what is commonly called a big bluff, and start in as a machinist. Now Jim had not worked in a machine shop except for about two weeks in a little shop somewhere in Indiana seven years before. He had tried the job in the belief that he wanted to learn a trade, but he soon tired of shop work because a clerking job seemed more suitable to a young gentleman of his refined tastes and lady-like manners. He had not prospered in the clerking business, and being out of a job and hard up, he remembered that the machine shop did not seem so bad after all. Stranded in a city where there were many shops and a scarcity of machinists, he concluded to take a chance and hire out as a machinist—on the strength of his two-weeks' shop experience! Now the city where Jim found himself stranded was the Queen City of the West, the center of machine tool building where a machinist usually can get a job if he can anywhere. He applied to the superintendent of one of the large shops, and upon being asked if he was an experienced man, he replied without hesitation in the affirmative. The "super" quickly let him understand that the shop really did not need any more help, this information being conveyed to properly cool off the applicant's expectancy of a bulky weekly pay envelope, but finally admitted that if Jim had any experience in cutting spur gears on a milling machine, he might employ him. Jim saw that his expected job would go "glimmering" if he did not convince the "old man" that gear cutting was his specialty, and he did not hesitate to state his qualification in very emphatic and convincing language. The "super" was given to understand that no gear-cutting job existed that he could not do in proper form.

Now in justice to Jim we must say that it was not his intention "to draw a long bow," but when a man is hard up and he feels quite uncertain where the money for the next week's board bill is coming from, a slight stretching of the truth may seem excusable that under ordinary circumstances would not be approved of.

Jim was told to go to work the next morning, and was placed in charge of the foreman of the milling department. A lot of gear blanks were turned over to him, together with a drawing and a few verbal instructions. Jim did not understand the situation very clearly, but he started to work. He busied himself for some time with the drawing, first scratching his head behind the right ear and then behind the left, and then finally concluded that he had better make friends with the man operating the next machine. He frankly confided how matters stood, and the man taking pity on him, showed Jim in as unostentatious a way as possible how to



"Two small teeth or one big one?"

set up the work, start the machine, manipulate the feed and work the index head. Jim started to work, taking great pains with the first gear. He indexed tooth after tooth carefully, and about noon he found that he had a space left that did not seem quite big enough for two teeth, but that clearly was too large for one tooth. He realized that here was a case where judgment meant more than experience(?), and in order to show that he knew what he was talking about, he called on the foreman, showed him the situation, and said: "What would you think to be best—to put in two small teeth or one big one in the space that I have left here? Personally, I would say that two small teeth would work the best." The foreman looked at Jim steadily for what seemed like a long time, swelling up as though he were about to explode; but he was a wise foreman and did not cuss. He simply said, "I wish, Jim, that you had given me your opinion about the two small teeth before you commenced to cut this gear. It would likely have saved you and me a lot of trouble. The next time that you hire out as an all-around machinist, be careful about giving your personal opinions unless you know what you are talking about. Perhaps you might be able to hold your job down a little longer than five hours if you do." That ended Jim's experience as a machinist in that shop.

MACHINE SHOP PRACTICE.*

PLANING AND LAYING OUT A BLANKING DIE.

When constructing a die, the degree of accuracy with which it is made, and the general finish, will depend somewhat upon the amount of work that it will be required to do, or the number of pieces to be produced. When this number is comparatively small, the most inexpensive die that will do the work properly should be made. Dies of this class are known as "emergency dies," as they are quickly made, and are not constructed to withstand long and continuous usage. When, however, a die is to be used incessantly for a long period, or, perhaps, until it is worn out through use, the materials used, and the quality of the workmanship, should be of the highest possible grade, and every detail brought as near perfection as possible. If the design of the die is at all complicated, it should be so constructed that the parts subjected to the greatest wear can be replaced, thus avoiding the necessity of making a new die.

The selection of a high grade of steel for dies is of paramount importance, and though such steel may be somewhat expensive, the increased efficiency of the die will more than compensate for this expenditure. In the Shop Operation Sheets accompanying this number, a simple form of blanking die is shown. This die, when in use, is held in place in a bolster, or die-bed, by the dove-tailed sides of the bolster, and by a key which is driven in between one side of the die and

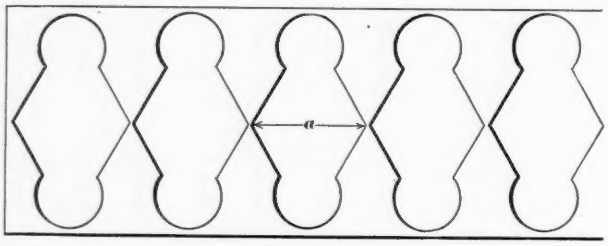


Fig. 1

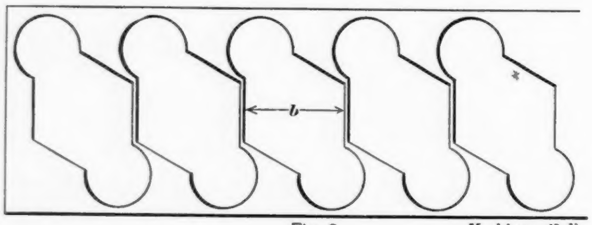


Fig. 2 *Machinery, N. Y.*

Figs. 1 and 2. Illustration of the Saving of Metal Effected by cutting the Blanks diagonally from the Stock.

the bolster. The latter is bolted to the table of the power press. It is not necessary to have a bolster for each die, for by making the die-fitting standard, a number of dies of nearly the same size may be used in the same bolster. In order that this may be done, the beveled sides of the die blanks are planed to an angle of 10 degrees, this being the standard angle to which the dove-tailed seats of the bolster are planed.

The Shop Operation Sheet explains the various steps in connection with planing and laying out a blanking die. The die proper should be finished before the punch-plate or stripper, as these are laid out from the die itself. A piece of high-grade, annealed steel, long enough to make several dies, should be selected, and cuts taken on both the top and bottom surfaces, the top surface being finished smooth. The piece is then set up on the planer as shown, with the finished, or top side, held against a beveled parallel strip, which, in turn, rests against an angle plate which is fastened to the planer platen. One edge of the piece is then planed. This finished edge is then placed next to the platen and the opposite edge finished. If one side of the parallel strip is at an angle of 10 degrees with the other, it is evident that the beveled edges of the die blank will have a taper of exactly 10 degrees. Care should be taken to see that the finished side of the blank bears on the platen at both ends, after it is clamped in place, in order that the beveled edges be made parallel. There should be no trouble in this connection if all chips have been carefully removed, as the blank, when pressed against the taper parallel will tend to move downward. A piece of thin paper, placed beneath each end of the work, will, however, enable one to determine whether or not the work is bearing properly on the platen.

After the steel strip is planed to fit the bolster, a piece of sufficient length for the die is cut off, and the die is ready to be laid out. Before this is done, however, a templet or master blank should first be made. Sheet steel is used for this purpose, the thickness of which will depend somewhat upon the size of the templet; for comparatively small work, steel about 3/32 inch thick will suffice. The outline of the templet should be laid out very carefully, and finished, by filing, to conform exactly to the required shape and size of the hole to be cut in the die blank. As the die we are considering is a plain blanking die, it will only be necessary to make a templet having the required outline of the blank. If, however, the die were to be of the blanking and piercing type, the location of the holes to be pierced in the blank would be laid out on the templet to facilitate locating them in their proper place in the die.

After the templet is accurately finished, the top surface of the die blank should be brightened with a piece of coarse emery cloth, and the surface prepared for laying out by either applying a solution composed of one part bluestone, and ten parts water (sulphate of copper), or by heating the die blank as described in Operation Sheet No. 74. The surface will then be either coppered or blued, depending upon the method employed, and on such surfaces all lines made by a sharp scriber will be bright, and made plainly visible by the contrast with the darker background.

The templet, or master blank, can now be used for laying out the die. It is first clamped centrally on the face of the die blank by the diemakers' clamp shown; then by following the outline of the templet with a sharp scriber, its shape is transferred to the face of the blank. Before locating the templet, however, the most economical way of cutting the blanks from the stock must be determined, that is, the way to obtain the greatest number of blanks from a given weight of stock. It will be seen then that the way in which the die is laid out will depend, to a great extent, on the shape of the blank. The die shown in Operation Sheet No. 75 is laid out in the way best adapted to most blanking operations, that is, so that the blank is cut at an angle of 90 degrees with the edge of the stock, but while this layout might be considered typical, it is not the most economical one for the particular shape of the blank shown. In this case, it is more economical to cut the blanks diagonally, with reference to the edge of the stock, as shown in Fig. 2. By comparing this illustration with Fig. 1, which shows the scrap from a section of stock which has been blanked in the usual manner, the saving in metal by diagonal blanking is apparent, as a much narrower strip of stock can be used. More blanks can also be obtained from a given length, as will be understood by noting the difference between the dimensions a and b in Figs. 1 and 2. When thousands of blanks are to be produced, the saving in metal that is effected is considerable.

When the shape of the blanks is such that there would, unavoidably, be a considerable amount of metal between the punched holes, the stock can, at times, be cut to a better advantage by so locating the stop, or gage pin (which regulates, by its position, the amount of metal left between the punched holes) that sufficient metal is left between the holes to permit the strip being turned around and again passed through the press. If a large number of blanks are to be made, however, a double blanking die would be preferable. The most economical layout can often be determined easily and quickly by cutting out a few paper templets, using the steel master blank as a gage, and arranging these in various ways until the best method of blanking is ascertained.

After the outline of the templet has been transferred to the die blank, the centers of the holes to be drilled for the purpose of removing the core, should be located. In the October issue, the way in which this core is removed, and the hole finished to conform to the master templet, will be explained.

* With Shop Operation Sheet Supplement.

LETTERS UPON PRACTICAL SUBJECTS.

PUNCH AND DIE FOR UNIFORM IRON BLANKS.

The accompanying engravings show a punch and die for the production of two 0.014 inch thick iron blanks, having almost identical outlines and proportions, and required to be produced in equal numbers. The blanks to be cut are shown in Fig. 2, together with a central piece of scrap resulting from the blanking operation. In addition to the blanking out of the pieces, two small holes, not shown in Fig. 2, are pierced at one end. By examining the design of the punch and die in Fig. 1, it will be seen that the tool is essentially made on the compound principle, the blanks being pierced and cut out complete in both the upper and the lower die at the same time, and simultaneously ejected from each, together with the central portion *A*, Fig. 2, or, in other words, one of the parts required, *C*, is cut out by the upper half of the die, or what is commonly called the punch, and the other blank, *B*, is cut out by the lower half of the tool, or what would be called the die. In Fig. 2, the pieces cut out have been shown with differently inclined cross-section lines, in order to more plainly indicate the work done by, and the action of, the tool illustrated. The three laminations—the two pieces to be cut, and the central piece of scrap—slide by gravity from the face of the die into a box at the rear of the press, the press being tilted for this purpose. The die, as will be seen, is made on the sub-press principle, four pins being used in each of the corners to properly align the upper and lower dies, thereby lessening the liability of accidentally shearing the edges, and at the same time insuring quick and accurate setting, which cannot be obtained conveniently by any other method. The tool is placed in an inclinable, overhanging, open-backed power press, running at 80 strokes per minute.

The general principles on which this die works are so simple that by comparing the shape of the pieces to be cut, as shown in Fig. 2, with the layout of the die in Fig. 1, no explanation can make the general working of the die any plainer than the engravings themselves. The construction of the die, however, may be of some interest. The holders consist of flat castings, machined where necessary, having four bosses, one at each corner, for the sub-press pins, and having projections or ribs cast where there are no outside cutting edges, for the purpose of strengthening the holder, and providing a backing for the sections. The tool steel pieces which form the cutting edges of the dies, are planed, drilled and tapped, and the piercing holes reamed slightly tapered, after which these sections are hardened and finished all over by surface grinding. Prior to the hardening of the cutting sections, however, grooves are planed transversely in them as shown in the small section between the plan of the upper and lower die in Fig. 1. These grooves are ½ inch wide and ⅜ inch deep; they are planed on the under sides and serve to decrease the tendency of the ends of the long steel pieces pulling away from the holder and rising up, thereby destroying the assembled condition of the punch and die, and making refitting of some parts necessary.

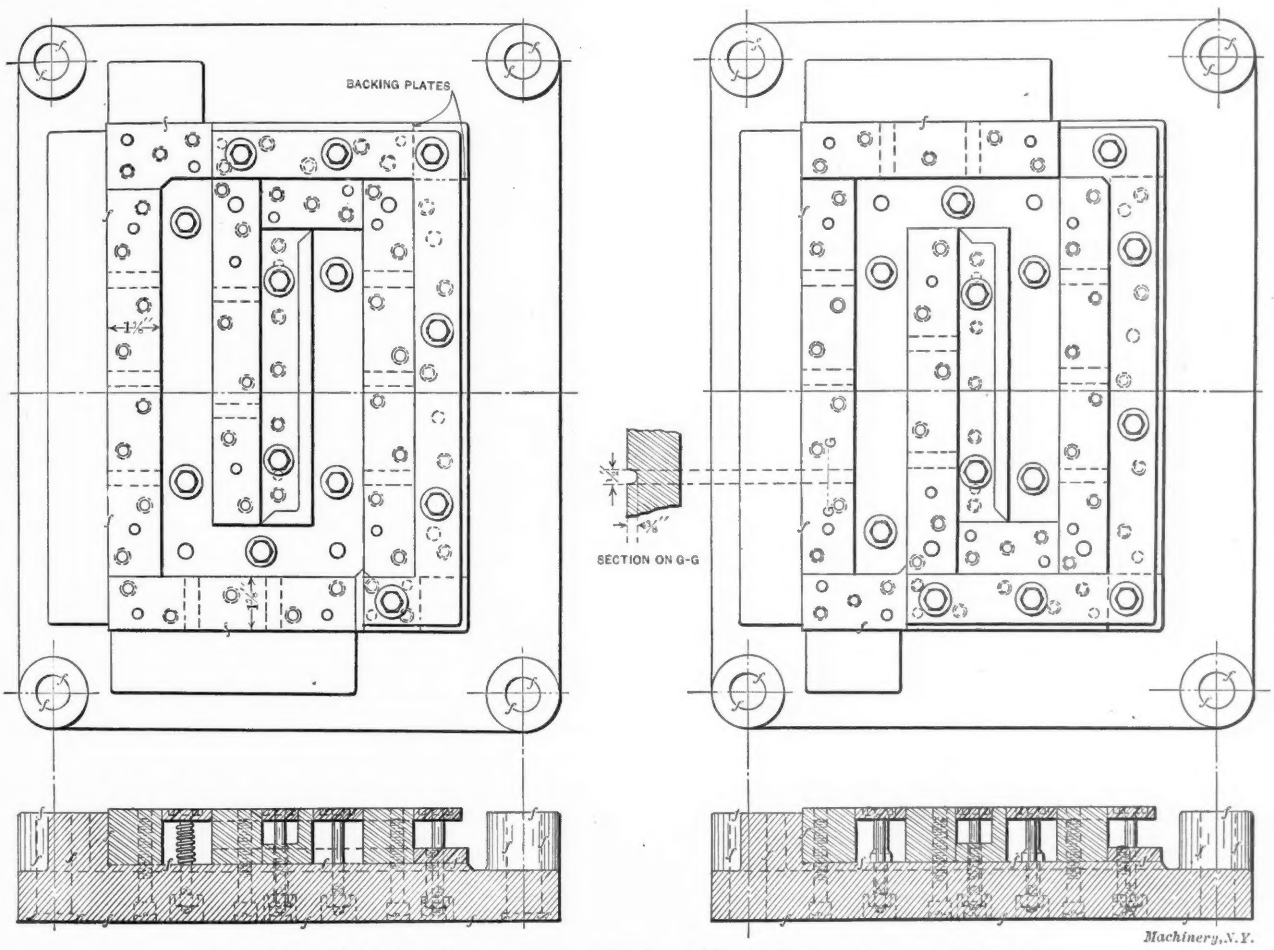


Fig. 1. Plan and Section of Upper and Lower Portions of Die for Cutting Pieces B and C in Fig. 2.

The constant impact common to blanking operations affects the long hardened steel members in these dies to a marked degree. After about ½ inch has been ground away on the top by repeated sharpenings, the long pieces will strain the threads on the screws which secure them to the face of the body of the die, and due to this strain, the long pieces will warp, the ends usually rising up. The grooves on the side next to the holder may not be an absolute cure for such undesirable conditions, but they tend to eliminate these troubles to a considerable extent. If the sections should warp in hardening, they may be straightened and replaced in their respective locations on the holders by peening on the top, care being taken not to strike near to the cutting edge. The steel parts of the upper and lower die having outside cutting edges are held in position not only by the screws coming through from the back, but also by ½ inch thick backing plates, doweled and screwed firmly to the holder.

The strippers are made of ½-inch boiler plate, and are planed on the outer face. They are forced to the top of the dies by coil springs made from ⅛-inch wire, and their movement is limited by the heads of ⅜-inch hexagon screws. The nuts on the lower ends of these screws are prevented from turning by a groove filed in the side with a small round file, and pins driven into the counterbored seats, fitting with their ends in the grooves. All adjusting of the strippers is done from the top of the dies. It will be noticed that stripper plates are provided for the sheet outside of the die, as well as for the parts which are cut out by the die. When the die was first designed, no stripper plates were provided for the outside, as the sheet iron from which the blanks were cut did not seem to require any stripping on the outside edges; but it was noticed that when the die was in operation, the outer edges of the stock sometimes bent down at quite an angle when the tool was cutting, resulting in unsatisfactory work when cutting blanks from the stock at places where the fit was slightly imperfect. The outer edges of the die also dulled more quickly than the inner edges, where strippers were used from necessity. By adding outer strippers to the die to clamp the stock, the troubles mentioned were overcome, and better work was turned out at the same time as the intervals between grindings became longer. Several years of experience have proved that when cutting sheet metal in large dies, it is by far the best practice to clamp the stock when cutting. When the stock is not so clamped, it is very liable to have a tendency to spread the die by straining the outer sections, or to cause other troubles.

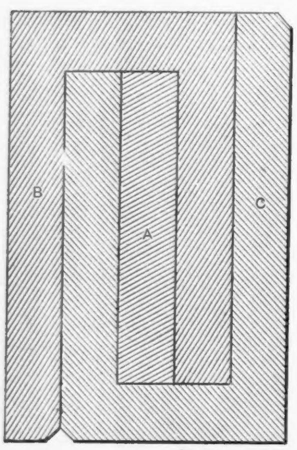


Fig. 2. Pieces B and C, cut by Die in Fig. 1, and the Scrap Piece A resulting from the Operation.

The piercing punches are driven into the holders, which is sufficient to hold them securely in place. Openings in the press ram flange are provided to allow the piercings to escape. In connection with this die, especial attention should be called to the small amount of scrap resulting from cutting out both of the odd-shaped blanks at once, the scrap for each two blanks being only the piece *A* in Fig. 2 and, of course, a narrow strip on each side of the stock used.

ENGINEER.

FORGING AN EYE-BOLT.

Some time ago the writer had occasion to make some 1¾-inch eye-bolts, that is, eye-bolts having 1¾-inch shank, for generators, and with the tools at hand he found it a rather difficult job. In the first place a 2 by 4 inch machine steel bar was hammered down enough for a shank about 2 inches in diameter. The piece was then cut off about 4 inches from the shoulder, and a 2-inch hole punched in the center, which hole was thereafter increased to 3 inches. The corners were then cut off, as shown at *B* in Fig. 2, and the inside and outside corners around the hole were removed in order to procure a circular section at this place. The result was a fairly good-looking job, but the time it required to make the forging was too great, it having required about three hours to make the first eye-bolt, and when the time was cut to 2½ hours, it was considered as doing well.

The writer, however, was not satisfied, and asked the superintendent for permission to make a forming tool, but, for some reason, this was refused. But later, receiving an order for as many as 12 eye-bolts, he undertook to make the tool "on his own hook," the superintendent having gone away for several days. The tool was made, and the time was cut to three-quarters of an hour on each eye-bolt, and by using the furnace, they could be made in one-half hour each. It took the writer and a helper about five hours to make the forming tool, and there was four hours machine work on it, making a total of nine hours, or a total cost, including shop cost, of about $11.00. Considering the cost of the first eye-bolt to be in the neighborhood of $4.00, including the shop cost, the writer thought that the saving in time more than paid for the tool. In the following is described how the tool was made.

One of the best of the eye-bolts previously made was filed up smooth and well rounded for the purpose of forming the tool. A ring was also made of 1¼-inch round machine steel, 3¼ inches inside diameter, as shown at *A*, Fig. 2, in-

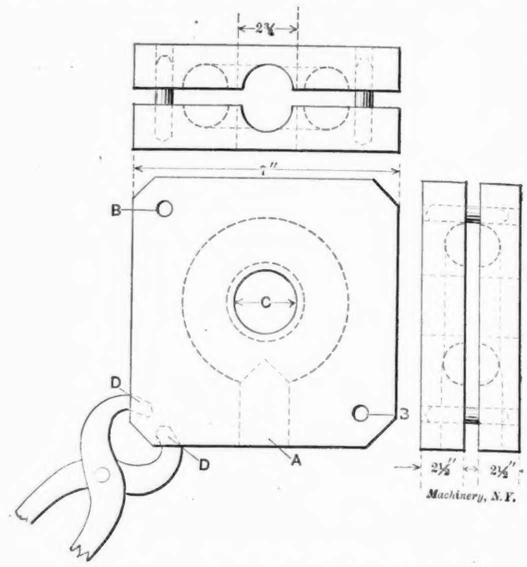


Fig. 1. Former or Die for Eye-bolt Forging.

tended for making the first indention in the tool. After this, two pieces of locomotive driving axles were obtained, and two pieces or plates made, 7 inches square by 2½ inches thick. The corners of these were hammered, as shown in Fig. 1. The two pieces were heated, and the ring placed between them, and then hammered together. After this, a piece of 1½-inch round steel was used for forming the groove for the shank as shown at *A*, in Fig. 1. The plates were then again heated, and after having removed the scale, the eye-bolt was put in place between them, and once again the plates were hammered together, after which the edges were worked up with a bob-punch to get them sharp. Then the eye-bolt was put between the plates again for the final blow.

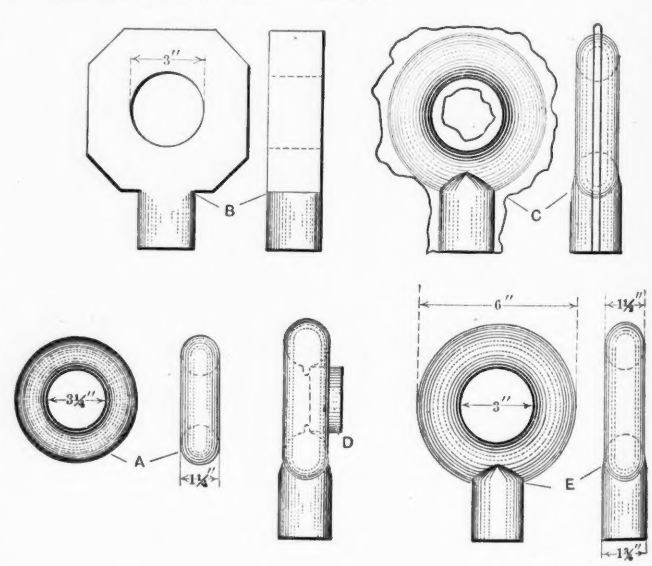


Fig. 2. Successive Steps in Forging an Eye-bolt.

When the steel plates had cooled off, two holes were drilled at opposite corners, as shown at *B* in Fig. 1, while the eye-bolt still remained in place. The plates were then bolted together, and a hole drilled through the center, as shown at *C* in Fig. 1. This hole was bored out to 2¾ inches diameter. The bolts were then taken out, and the holes at the corners drilled for ⅞-inch pins, which were then driven into the bottom part, with the ends tapered slightly on the outer end, so as to enter the holes in the upper part of the tool. The pins were of such length that when the dies were placed together, the pins

were below the surface of the dies. Finally holes were drilled in one corner of the upper die at *D*, Fig. 1, to fit the jaws of the tongs for handling it.

The blank forgings are now made in the same way as before, and as shown at *B* in Fig. 2. The blanks are placed between the forming dies, and these are hammered together, and when the eye-bolt is taken out, the surplus metal will be found around the outside of the eye-bolt and in the hole, as shown at *C*, in Fig. 2. This fin is cut off from the outside, and the eye-bolt is then again heated and placed in the die for a final blow. Then a short piece of steel, 3 inches in diameter and about 1½ inch long, as shown at *D*, Fig. 2, is placed on the die of the steam hammer, and a light blow will clean out the inside edge of the eye-bolt, leaving it finished as shown at *E*, in Fig. 2, excepting for cutting the shank to the proper length.

Decatur, Ill. GEORGE T. COLES.

A ROLLING OPERATION ON TYPE-WRITER PARTS.

There are a great many interesting operations, common enough in some shops, which the workmen in other shops seldom or never hear about. A shop which has many things of interest and value to the wide-awake machinist is the Remington-Sholes typewriter factory. One of the many in-

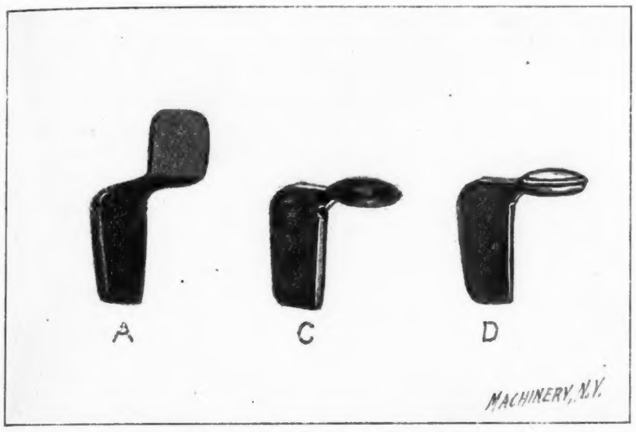


Fig. 1. Part Stamped and Rolled to Shape, at Various Stages of Completion.

teresting operations carried out in this shop is a process for rolling a head on a stamped punching. The process may not be new, but it is certain to be of interest to many of the readers of MACHINERY. In Fig. 1 is illustrated a small detail for a typewriter in full size; at *A* is the piece as cut in a die from stock about 3/32 inch thick. This part is cut in the sub-press die *B*, in Fig. 2. The piece shown at *C*, Fig. 1, is the same part with a head rolled on it. It will be noticed that there are some fins around the edge of the rolled or formed

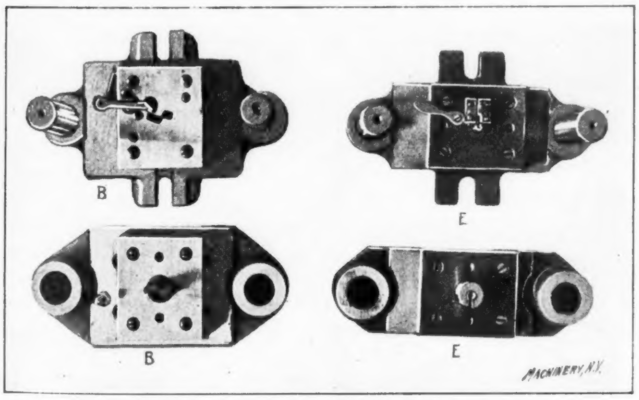


Fig. 2. Sub-press Dies used for Stamping and Trimming Part in Fig. 1.

portions. At *D*, in Fig. 1, the piece is shown trimmed off, the trimming being done in a sub-press die, as shown at *E*, in Fig. 2. The stem of the piece is inserted in the slot in the lower die shown at the top. It is clamped by means of the eccentric lever shown at one side, the trimming being done by the upper half of the die.

It would be very difficult, if not entirely impossible, to do a satisfactory forming job of this type in a punch press. The work is done in a special rolling device, the elementary principle of which is shown in Fig. 3. The heads *F* and *G* of the device rock up and down about pivots, as shown, between the positions indicated in the full lines and the positions shown in the dotted lines. The piece to be formed is held in a die between *F* and *G*, and the heads, as they rapidly move up and down, gradually are fed toward each other, thereby rolling the metal into the shape indicated. The appearance of one of these heads, *G*, is shown in Fig. 4. ETHAN VIALL.

Decatur, Ill.

MAKING BLUE-PRINTS WITHOUT A FRAME.

It may not have occurred to many of the readers of MACHINERY that blue-prints of small size can be made without a blue-printing frame. An ordinary window can be used if the sun shines through it, and a blue-print can be made in any

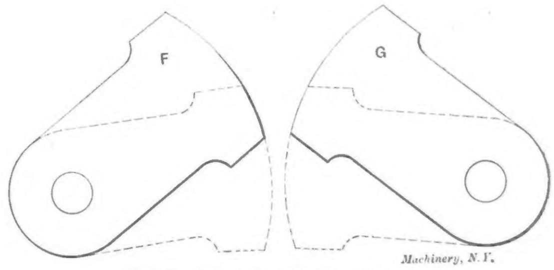


Fig. 3. Principle of Rolling Device.

window. An ordinary thick bath towel is placed behind the print, the tracing being placed against the glass. The towel should be folded into two or three thicknesses and arranged so that no wrinkle or uneven part lies against the print. A small drawing board may then be placed against the towel, but it is better to tack the towel at its corners to the board.

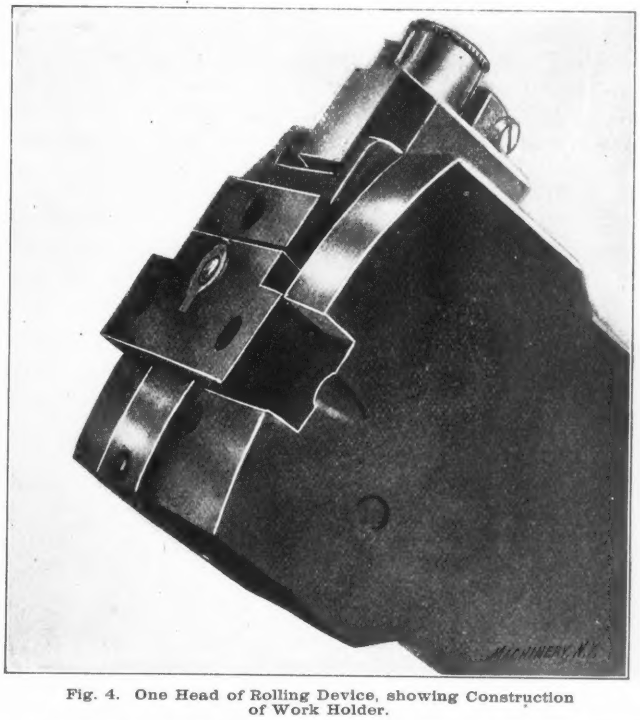


Fig. 4. One Head of Rolling Device, showing Construction of Work Holder.

It is also advisable to attach the tracing to the printing paper by small gummed stickers, to keep them in the proper position and to prevent sliding. Ordinary stickers cut into narrow strips will be sufficient, and need engage only a narrow surface on both the paper and the tracing, to serve the purpose. The print can then be frequently looked at without disturbing the relation, and can be easily torn off without injuring it or the tracing. Fragments of the stickers are easily scraped off. The printing paper and tracing can be held by a blank projecting edge against the window while the towel and board are being pressed against them. Any suitable means for holding the board in place may be used.

Another improvised printing outfit used by the writer consists simply in spreading the towel evenly upon the floor where the sun can strike it, placing the printing paper and tracing upon it, and then merely covering these with a thick

plate of glass. When first laid down, the glass may be pressed downward with considerable pressure, after which its weight alone will be sufficient to keep the paper smooth. This will be the case if two or three thicknesses of bath towel are used. This plan works perfectly for sheets 10 × 15 inches and below, this being the size used by the writer. Larger prints could doubtless be made in this way if weights were put upon the corners of the glass.

Another very practical way of making small prints is to use a smooth board with a slightly curved face. A tack placed in each corner of the tracing and print will cause them to snugly lie against the curved surface of the board, making a sharp and clear print. No glass is needed. C. E. Burnap.

Battle Creek, Mich.

TO SET OVER TAIL-STOCK TO TURN A TAPER.

In these days of taper turning attachments, it is not often that one has to set over a tailstock to turn a taper. Sometimes, however, this has to be done, and the methods usually given are not only clumsy and troublesome, but almost invariably end up with the statement that no account has been taken of the effect produced by the uncertain depth to which the center holes have been drilled. It is not conducive to one's respect for the author of a rule, after figuring out by proportion how much to set over a tailstock to turn a taper of 0.650 inch on a piece 3 21/32 inches long, to be told that this is only approximate and the exact setting must be determined by trial. As a better method, and one which not only eliminates all figuring, but also gets rid entirely of the uncertainty of the center holes, I venture to offer to the readers of Machinery a method which I have used for some time in the instrument shop of the Emerson McMillin Observatory.

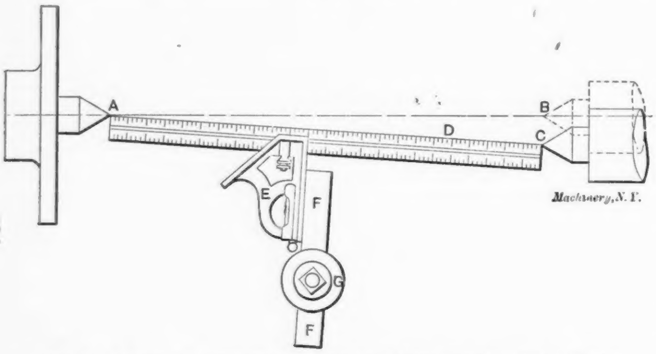


Fig. 1. Method of obtaining Setting for Taper Turning; First Step.

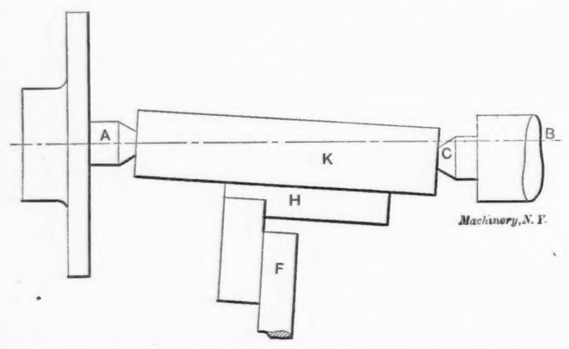


Fig. 2. Setting the Tail-stock for Taper Turning: Second Step.

The piece to be turned should first have its ends faced off true, and a smooth cut taken over about two or three inches of its length, the centers being accurately in line. Then take the piece out of the lathe and move the tail-stock until the *extreme points* of the centers are exactly one foot apart, as shown in Fig. 1, the tail-center B being dotted. Then, in any convenient way, set over the tail-center exactly one-half the required taper per foot; that is, the distance $B\ C$ should be one-half the required taper per foot. A piece F, which has been planed smooth and true on at least three sides, should then be placed in the tool-post G. This piece should be about the size of the body of the tools used in the lathe. A machinist's steel square with a blade one foot long, and preferably with a sliding head, should be held against the side of F and this latter turned in the tool-post until the edge of the blade D "cuts" the points of the centers A and C. The piece F should then be clamped, care being used to prevent changing this adjustment in clamping. It is evident that the side of F will now make an angle with a perpendicular to the axis $A\ B$ of the lathe, which is equal to half the angle of the required taper. Now move up the tail-stock, and place the piece to be turned (K, Fig. 2) between the centers. Then hold a small square H against the piece F and set back the tail-stock until the blade of the square shuts out the light when held against F and brought up to the piece K. Should K be longer than one foot, obviously the tail-stock should be set over more instead of being set back. If care be used in each step of this process, a taper three or four inches long, when tried with a chalk line along its side, just as it comes from the lathe, will show a bearing for its entire length. While it has taken some time to describe this process, I do not think it takes over three minutes in actual practice to set over a tail-stock to turn a given taper after the work is ready. H. C. Lord.

Columbus, Ohio.

HOME-MADE TOOLS FOR DIE-MAKERS.

A few home-made tools are shown in the accompanying engravings. The construction of these tools is very simple, and they will make a desirable addition to a die-maker's collection. During several years experience as die-maker, the writer has noted with considerable interest many different methods of locating round piercing punches in a punch holder, the means employed differing as widely as the men who used them, ranging all the way from the crude method of transferring through the die by means of a twist drill, to the accurate master plate which is in almost universal use in the watch-making factories.

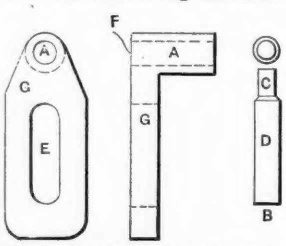


Fig. 1. Device for Locating Holes for Punches in Punch Holders.

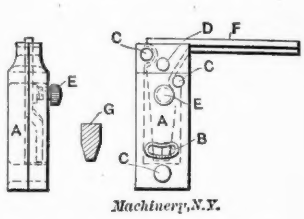


Fig. 2. Die-makers' Square or Protractor.

In Fig. 1 is shown a device which the writer has used considerably for locating the punches for small open dies, with the best results. The bracket G is made from tool steel, and the hole A is ground so that it is accurately at right angles with the face F. This can best be done on the face-plate of the bench lathe, using a revolving steel lap charged with diamond dust or carborundum. When using the tool for locating small round punches in the punch holder from the die, a piece of drill rod is first turned up, as shown at B, so that the diameter of the portion C equals the size of the hole in the die, and the part D is a close sliding fit in hole A. The piece B is then pressed into hole A, and the end C of the pin is placed in the hole in the die. One of the punches, that has previously been put into the punch-holder, is now permitted to enter its corresponding hole in the die, and when this is done, scribe lightly through the elongated hole E with a bent scriber on the punch-holder. After this, the die and bracket G are removed and a hole drilled and tapped in the punch-holder for a clamping screw in the center of the scribed outline. No great accuracy is needed, as the slot E should be enough larger than the screw to admit of considerable side-play, and the screw can be placed anywhere within the length of the slot. After having drilled and tapped this hole, the die and punch are again assembled, and carefully levelled up with parallels. The bracket G is placed on the punch-holder, and the screw in slot E is put in position and tightened, thereby binding the bracket to the punch holder, a bent screw-driver being used for tightening up the screw, if it has a slotted head. It is evident that the end of pin B which locates hole A of the bracket G now being clamped to the punch holder, is exactly in the position which the punch should

occupy in the finished tool, because end C of pin B enters the corresponding hole in the die. All that therefore remains now is to place the punch-holder on the face-plate of a lathe, indicate the pin, in the usual way, so as to insure the hole being bored central, remove the locating bracket, and bore the hole for the punch. This method, of course, leaves a small threaded hole in the punch-holder, but this can easily be plugged up. Should it, however, be objectionable to have a tapped hole in the punch-holder, the bracket may be held to the punch-holder with a little solder on each side, care being taken that the bracket is held down firmly to the holder when the solder is applied.

In Fig. 2 is shown a die square, which, when carefully made, is a very handy little tool. As will be seen, the blade can be adjusted from a 90-degree angle, or a perfect square, to an angle slightly larger or slightly smaller than 90 degrees. This tool is used for measuring the clearance of dies. By this means the die maker can measure the angle of clearance without the use of a regular protractor, and he can set this tool to the angle required for different jobs. The body part A is made of tool steel in two pieces, each side being recessed to accommodate the blade F. One side has a slot cut through it at B, which is bevelled and graduated. The rivets C shown serve to hold the two parts of the body together. The blade F is made of tool steel and is pivoted on the pin D, and locked by means of a knurled screw E; the point of which rests on a hardened disk, to prevent marring the blade. The projecting

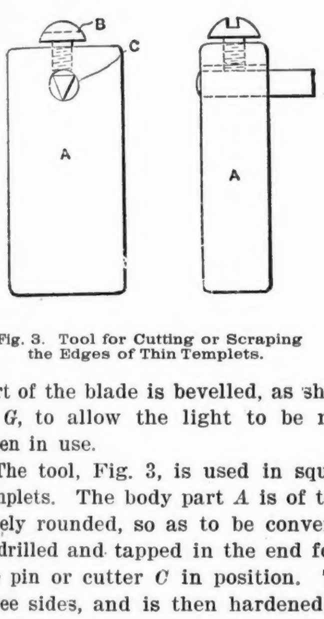


Fig. 3. Tool for Cutting or Scraping the Edges of Thin Templets.

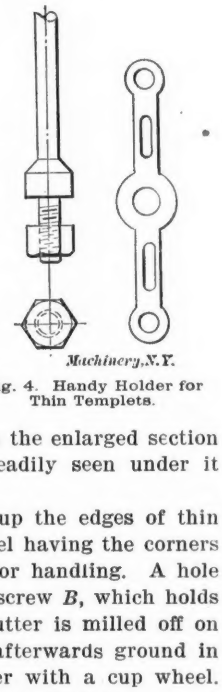


Fig. 4. Handy Holder for Thin Templets.

part of the blade is bevelled, as shown in the enlarged section at G, to allow the light to be more readily seen under it when in use.

The tool, Fig. 3, is used in squaring up the edges of thin templets. The body part A is of tool steel having the corners nicely rounded, so as to be convenient for handling. A hole is drilled and tapped in the end for the screw B, which holds the pin or cutter C in position. This cutter is milled off on three sides, and is then hardened, and afterwards ground in the bench lathe, using a tool-post grinder with a cup wheel. When the cutting edge gets dull, the screw B is loosened, and the cutter C is turned around one-third of a revolution, so that the next cutting edge can be presented to the work. When all the edges are dull, the tool can again be ground on all the three sides.

The tool shown in Fig. 4 is a simple templet holder for small templets, which does away with the soldering on of a piece of wire, in which operation one usually manages to get part of the solder over the edge of the templet, which, whether left on or filed off, does not add to its accuracy. Another advantage of this holder is that when using a templet which is thin, and therefore has a tendency to spring, washers can be roughed out approximately the shape of the templet, only a little smaller, and the templet can be placed between them and the nut screwed up to hold the templet between the washers. It can then be held firmly in a flat position. As an example may be shown the templet at the right side in Fig. 4, which is very thin, and would be difficult to work through a die in the ordinary way, but by making two washers or guides, not illustrated, of approximately the same shape as this templet, it may be held straight and flat. When the washers holding the templet are long and narrow, as in the present case, it is well to bend them a little before binding with the nut, so as to prevent the ends from lifting up when the nuts are tightened. ROY PLAISTED.

Philadelphia, Pa.

SPECIAL SHOP CAR FOR CURVES OF SHORT RADII.

In manufacturing establishments, where small cars are used for transferring material and other supplies from one point to another, it is common to have turn-tables for changing the

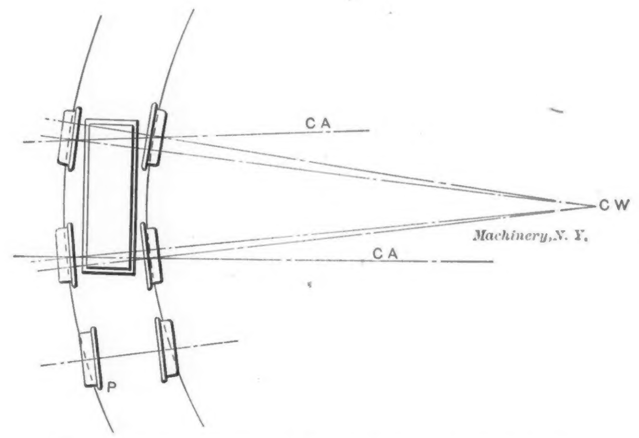


Fig. 1. Action of Car-wheels shown in Fig. 2 when on a Curve of Short Radius.

direction of the cars. Under these conditions, the car must be run onto the turn-table with some care, especially when the wheel base of the car is as long as the turn-table will admit, and much time is often lost in placing the car and swinging the turn-table to bring the car into position to take the new direction. For this and other reasons, curves instead of turn-tables are preferable, but in a manufacturing plant it is obvious that the curves must needs be of such short radius that cars of special construction are necessary. The object of this article is to describe a car that was especially designed to meet these requirements, *viz.*, a car that will automatically adjust itself from running on a straight track to running on a curved track of short radius, say twelve feet, and which on passing the curve readjust itself again to straight running. The accompanying illustration, Fig. 1,

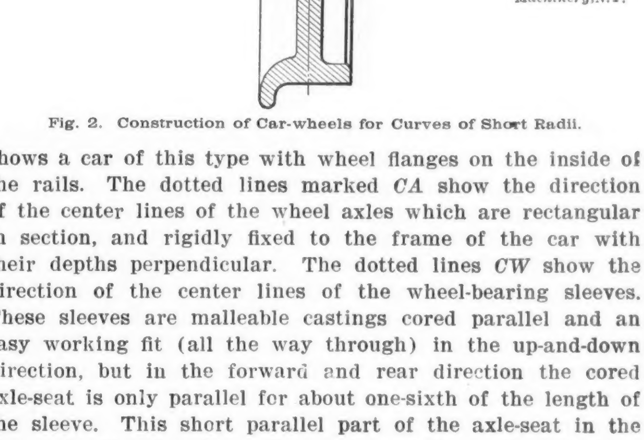


Fig. 2. Construction of Car-wheels for Curves of Short Radii.

shows a car of this type with wheel flanges on the inside of the rails. The dotted lines marked CA show the direction of the center lines of the wheel axles which are rectangular in section, and rigidly fixed to the frame of the car with their depths perpendicular. The dotted lines CW show the direction of the center lines of the wheel-bearing sleeves. These sleeves are malleable castings cored parallel and an easy working fit (all the way through) in the up-and-down direction, but in the forward and rear direction the cored axle-seat is only parallel for about one-sixth of the length of the sleeve. This short parallel part of the axle-seat in the sleeve is directly above the center of the rail, and from each end of this short parallel part to each end of the sleeve, the cored axle seat flares, in both forward and rear directions, an amount depending on the radius of the curve the car is intended to traverse. This short parallel part must be loose

enough on the axle to let the sleeve swivel the full amount which the flared parts permit.

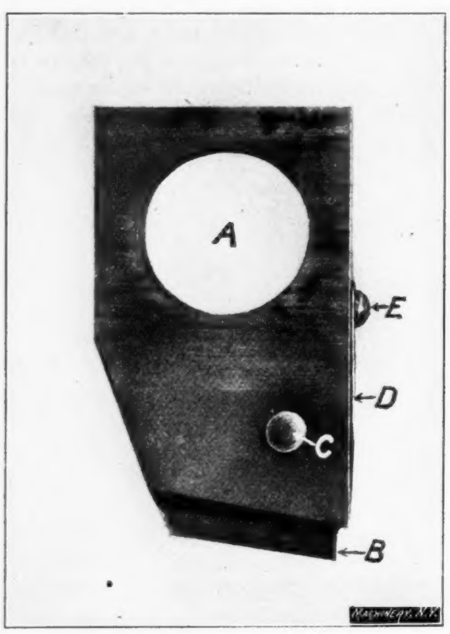
Now, if the car is pushed or pulled forward or backward, the axle is forced against the short parallel part of the axle-seat, and if the car is on a straight track, the wheel bearings will stand parallel with the axles. When a curve in the track is reached, and the flange of the wheel comes in contact with the rail, as shown at *P* in the engraving, Fig. 1, the wheel will force the sleeve to swivel, and the short parallel part of the axle-seat in the sleeve will be thrown out of line with the axle, but will always have a tendency to come back into line, and will do so as soon as the car reaches a straight piece of track.

In the detail construction in the engraving, Fig. 2, *A* is the axle, *B* is the wheel-bearing sleeve, *C* is a thin steel casing split lengthwise and pressed on the sleeve with the split at the top, and C_1 is a thin steel bushing in the wheel-hub. (If C_1 is split, it must be done spirally.) The part *D* is a cap with two set-screws in it to keep the wheel in place on the sleeve; *E* is a pin driven through the end of the axle between the end of the sleeve *B* and the inside of the cap *D*. The end of the sleeve *B*, where the pin goes through the axle, is convex in the forward and rear directions, the radius of the convexity being the distance from that end of the sleeve to the center of the short parallel part of the axle-seat. When the pin in the axle is against the highest part of the convex end of the sleeve, the end of the axle should clear the inside of the cap *D* by about one-eighth inch. JAMES T. GRIMSHAW.

Detroit, Mich.

TOOL FOR GRADUATING.

A very good tool for graduating work in the milling machine, when the index head is used for spacing, is shown in the engraving below. The tool is held stationary on the arbor in the same manner as a regular milling cutter, and the work is moved back and forth under it, the table stops being used to get the correct length of stroke. The body of the tool is made of machine steel, ½ inch thick, 1½ inch wide, and 2¾ inches from the top to the cutting point. The hole *A* is bored for a 1-inch arbor.

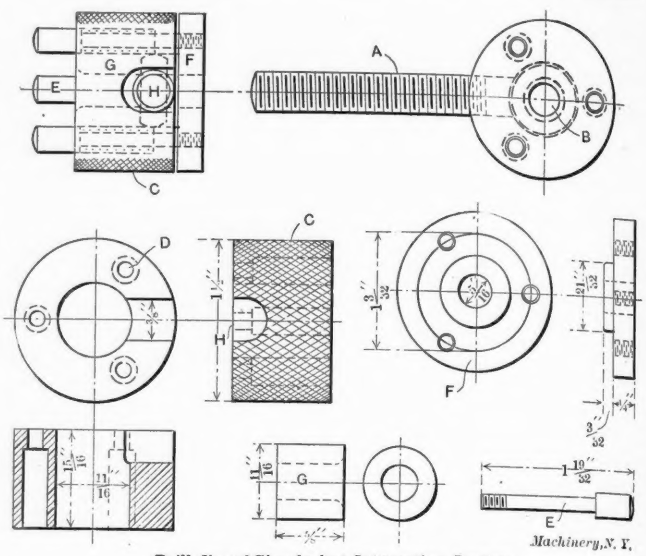


Tool for Graduating.

The cutter blade *B* fits freely into a slot milled in the machine steel body. It is made of ⅛ x 1-inch tool steel, hardened and tempered, and the cutting edge is ground to a 60-degree angle. The cutter is also ground at an angle of 80 degrees to the front edge of the body for clearance. The pin *C* which holds the cutter in the slot is of ¼-inch drill rod. The spring *D* at the front of the tool, which keeps the cutter in proper position when cutting and allows it to ease up when backing out, is ¼ inch wide and 1¼ inch long, and is held by a small screw *E*. Rapid, clean work can be done with this tool without danger of breaking the point. ETHAN VIALL.

INTERESTING DRILL JIG.

The drill jig described in the following is so simple in its construction, and so easily manipulated, that I think it will be suggestive for improvement in drill jig design to some of the readers of MACHINERY. In the upper part of the line engraving the jig is shown assembled, with the piece *A* to be drilled in place in the jig. In the lower part are shown the details of the device. The piece to be drilled is turned and threaded in the screw machine, from bar stock, and the spherical head slab-milled in the milling machine. The hole to be drilled is the hole *B* in the head. The main body *C* of the jig is knurled to permit a good grip in handling, and is bored to 11/16 inch diameter, which corresponds with the diameter of the spherical head of the piece to be drilled. The three small counterbored holes *D* permit of the introduction of the feet or plungers *E*, around which are placed small



Drill Jig of Simple but Interesting Design.

helical springs. The stems of these feet *E* pass beyond the body *C*, and are threaded on the upper ends, the threaded portions entering into the cover *F*. The jig is now complete except for the bushing *G*, which, of course, is hardened, and made of tool steel. This bushing is pressed into the body *C*, and is just long enough to leave, when it is pressed down flush, sufficient room for the flattened head of eye-bolt *A*. The slot at *H* allows clearance for the stem of *A*, which latter provides a very convenient handle when drilling. In the event of a piece with a shorter stem being used, a small handle can be driven or threaded into the side of the body *C* to hold it while drilling.

With the feet *E* resting upon the drill press table, and the thumb and fore-finger on either side of the body *C*, press downward in order to remove the piece; then, after inserting a new blank, the pressure on the body *C* is released, and the small helical springs bring the body *C* up against the cover *F*, thereby holding the work securely. The jig is now turned over, and, using *F* as a base, the hole is drilled through the work from the bushing *G*. C. H. RAMSEY.

Paterson, N. J.

AUTOMATIC LATHE STOP AND TELL-TALE.

I have seen one or two devices around the shop for automatically stopping the lathe, or warning the operator when the tool had reached the end of its cut, which were very primitive in design, but served the purpose well.

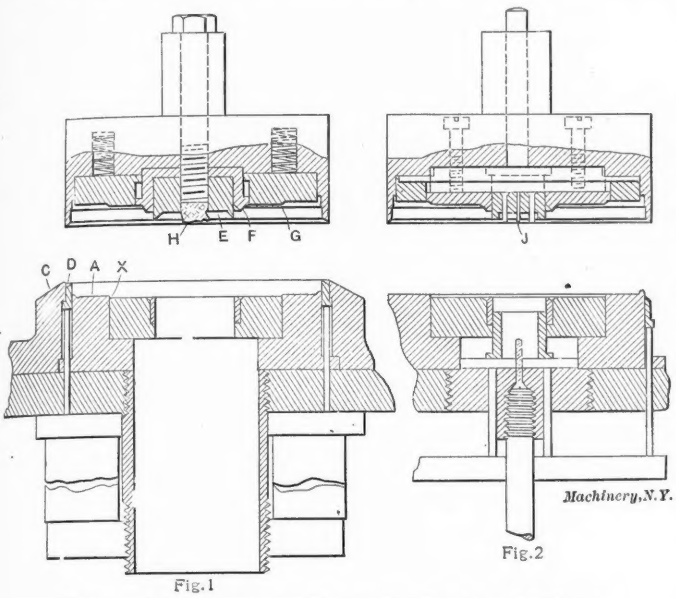
One way of stopping the lathe is to hang a weight on a cord which is attached to the shipper and which passes over a rod on a level with the bottom of the shipper. The weight is set on the back V of the lathe in such a position that when the carriage has reached the end of the cut, it will push off the weight, which will cause the shipper to be pulled over, thus stopping the machine. This device is used mostly on lathes with jobs running half an hour or so, and where the operator is running some other machine.

Another arrangement used by the piece workers on roll turning, where they do not stop the lathe at all, is a tell-tale. It is a strip of sheet steel fastened by one end to the carriage and set in such a position that when the tool has reached the end of the cut, it will rub against the faceplate, making a noise like an old style watchman's rattle, thus notifying the operator. PAUL W. ABBOTT.

Lowell, Mass.

PUNCHES AND DIES FOR CAN ENDS.

I was much interested in Mr. Washburn's description of his toggle drawing punch for can ends (see February, 1908, issue of MACHINERY), as I have been closely connected with the can business for a few years. I like the toggle punch for shallow, unembossed, push-through work, but for the general line of can tops and bottoms I prefer a single action combination die, as there is usually some embossing to be done in addition to the cutting and drawing of the bottom; a top with an opening is also usually required on fruit and vegetable or "packers'" cans. This opening is used for filling, and is later closed with a cap. It has been found that a lip on the mouth of



Figs. 1 and 2. Punches and Dies for Can Covers and Bottoms.

a can end is essential to rapid and economical production, as it makes the entrance of the body into the ends more easy, and also maintains a good tight fit so as to make a good joint with the least amount of solder.

The style of punch and die that produces a large portion of the can ends used by packers and supplied by the so-called can trust, is shown in Fig. 1, and might be termed a single action, cutting, drawing, and embossing combination. In addition to the operations mentioned, the "single" dies, and especially those of odd sizes, are further combined so as to make bottoms and tops with various size openings ranging from 1⅜ inch to 3¾ inches in diameter; and even after this was accomplished the blank from the 1⅜-inch opening was bumped up into a roofing tag.

The gang dies are of identical construction, and are part of a line of machines that make a can and make three tops and three bottoms at each stroke; the sheet of tin is turned over to cut three more of each at the next stroke; then the stock goes to another gang press that makes six can caps and ten smaller caps for bottles. By this time the sheet is so well decorated with holes that it can be handled only with a pitchfork. This scrap is shipped to a detinning plant. The blanks from the can top openings are worked up under other presses, usually automatic. Some sheets make as high as twenty-four tops and bottoms and a relative number of smaller pieces.

The engraving above of the die will probably need some slight explanation. Center block A is made the same diameter as the outside of the can body, as this part determines the smallest possible diameter of the inside of the can end. The center block is bored out to receive die centers made for different size openings, and as these all come within the diameter of the panel X, the height of all must be alike at this point, though the contour may vary inside the diameter of the panel. It is my practice to make the contour of the die centers lower than the rest of the bottoms, which makes it possible to run out tops as required, and by removing the punch only and changing to punch centers adapted to bottoms, as shown, bottoms can be made without changing the die or setting the die or press, which results in a considerable saving of the die setter's time when only one or two dies are available.

It will be readily seen that it is not necessary to have solid die centers or center blocks for bottoms, as the punch center determines the convexity and the size and shape of the panel, provided the die center does not interfere. Sometimes tops are required without the panel; then the die center is raised an amount equal to the height of the panel, and the punch center shortened an equal amount, and a separate knockout used. The part C is the cutting edge, and D the pressure ring which can have a bevel of from 20 to 25 degrees, as a shallow draw has so little tendency to wrinkle, and because such wrinkles can be ironed out with a high pressure from the rubber barrel, there being little danger of bursting the end.

The cutting edge of the punch is bevelled to fit the ring, which permits considerable upsetting before it is necessary to refit. This cutting edge of the punch is 5/16 to 3/8 inch ahead of the embossing or bottoming point; this feature permits the die maker to upset and fit the punch to the cutting edge and ring without sinking back the entire interior of the punch, which means a great saving of time, when one considers that the punch can be fitted eight or ten times before sinking back. The diameter of this portion is made 0.010 inch to 0.012 inch larger than the proper size up to within 3/32 inch of the knockout, then bored the proper diameter to draw the metal to the size of the center block; this double diameter draws, makes the end too large, and then redraws most of it to the proper size, leaving the lip flared out slightly, as shown exaggerated in the views of the tops and bottoms—a small detail that saves thousands of cans and many pounds of solder, and results in a higher speed of production. The forming punch F forms the metal around the hole blanked by punch E, while G forms the bead and panel and acts as a knockout through the springs as shown. The punch parts are held by a cap-screw, and a bit of soft rubber H insures the shedding of the blank.

In the roofing tag combination, the blanking punch is fitted with a pick-up piercing pin J (Fig. 2) pointed to burst a hole instead of piercing it, and slightly reduced in diameter so as to pick up the work. Knock-off pins are provided, and they and the knockout ring are operated by a ⅜- by ½-inch bar actuated by the pin shown in the shank of the punch. The punch center and ring are slotted to make room and give action to the stripping bar. The die space is filled up with a forming post, forming and stripping ring and stripping pins

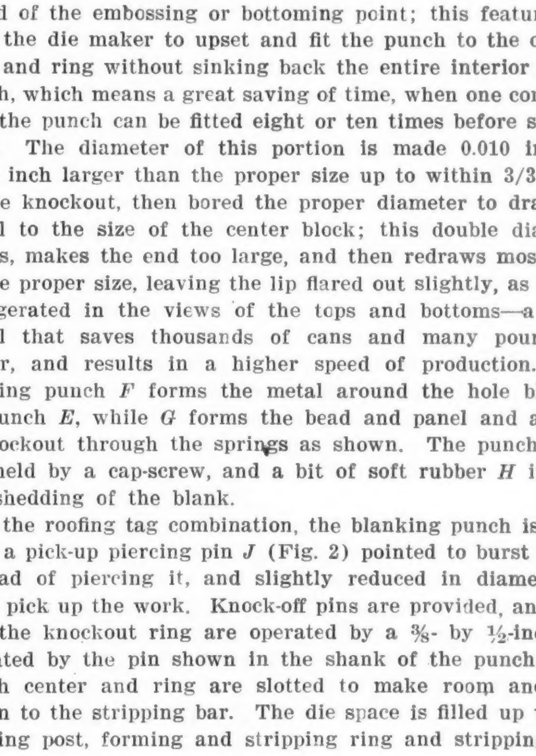


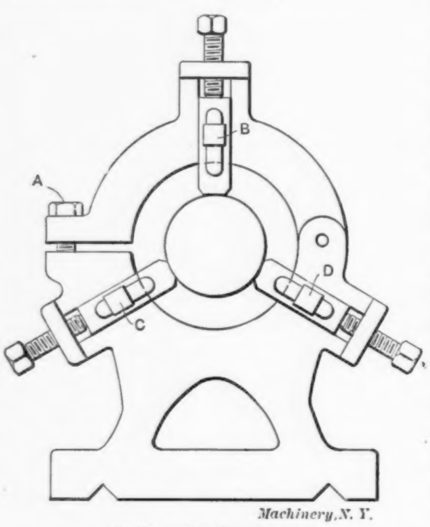
Fig. 3. Plain and Paneled Can Tops and Bottoms.

supported by the threaded plug screwed into the die plate. The ring is intended mainly to hold the blank control on the down stroke, so the center pins are some little shorter than the others. A stud instead of a pipe now supports the rubber barrel, as there are now no blanks to go through. This seems like a lot of work to save a small piece of tin, but I know of one factory that makes 25,000,000 of these blanks yearly. I want to call attention to the difference between these two punches: The knockout in Fig. 1 begins to strip the work an instant after it is formed, and the work lies on the die but falls with the movement of the stock, the press being inclined as usual. With the style shown in Fig. 2 the work is picked up almost to the top of the stroke before falling, hence it is out of the way and permits easier movement of the stock. The roofing tag must be picked up high enough to drop clear of the die; if it drops in the die the next piece will be spoiled.

SIRIUS.

SETTING THE STEADY-REST.

After reading Mr. J. J. Voelcker's remarks in the May issue of MACHINERY, relating to the use of the steady-rest, I would say that his remarks are very good as far as they go, but one of the most important suggestions has been left out, which is necessary to make the subject more complete. This important point is that of setting the steady-rest. It seems to be quite common among machinists simply to set the steady-rest by screwing down the jaws upon the work until they have what they think is a running fit between the work and the jaws. This, of course, is a very poor way, especially for finished work, and would, as Mr. Voelcker says, need emery cloth, with the cloth side next to the work, in order to prevent marring the finished surface. Even then, however, there is a liability of scratching the work if it has to be run for any length of time, because the steady-rest is set too positive to allow for expansion of the metal by the heat due to friction. The writer has always found that the best way to set the steady-rest is that indicated in the accompanying illustration. Referring to the engraving, the binding screw *A* should be screwed down with the fingers. This gives the workman a chance to adjust the tension of the jaws on the work every few minutes, and especially when filing the work, this gives very good results, as the nut can be adjusted according to the expansion of the work. It is admitted that emery cloth is a good thing to use in most cases, but there is no need of it if the precaution mentioned above is taken, providing the jaws have ordinarily smooth faces. The nuts on the bolts *B*, *C*, and *D*, for adjusting the jaws themselves, should be tightened positively with a wrench as soon as the work has been set central.

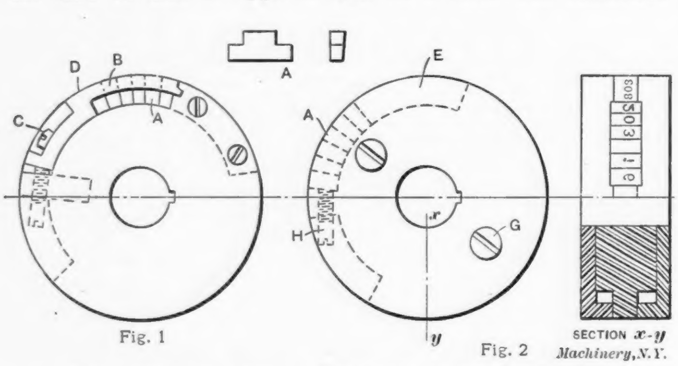


Setting the Steady-rest.

New Britain, Conn. J. W. DICKINSON.

DIE-HOLDERS FOR MARKING MACHINE.

In the manufacture of tools requiring a great many different marks to designate the different parts, the cost and up-keep of the dies is no small item. Having this in view, the idea of dies or type to lock in a form was submitted



Figs. 1 and 2. Two Types of Die-holders for Marking Machine.

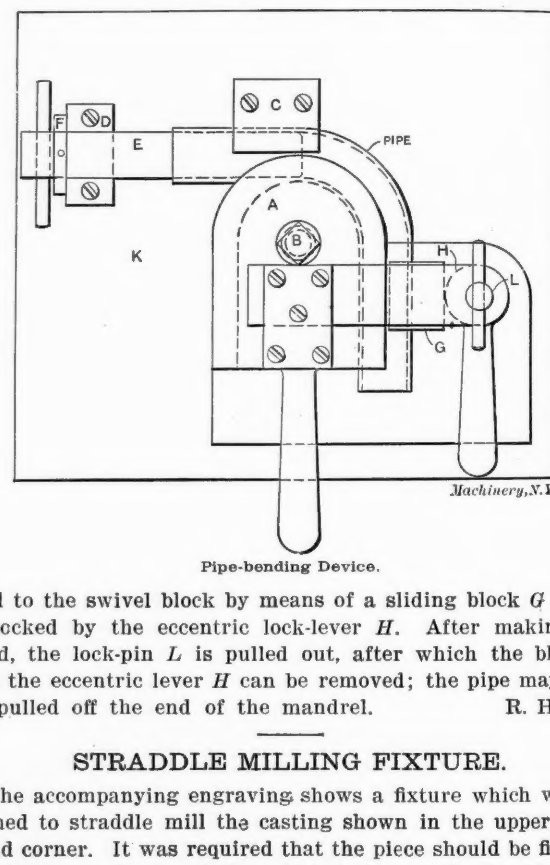
to the builders of a marking machine, and the holder, Fig. 1, with three sets of figures and an alphabet, were made, in which the type *A* (shown also in detail), were held in place by a segment *B* which was fastened by screws *C*. This holder was not a success, as segment *B* would break at *D*, and, there being no way to hold the point from side play, the type would work loose. To overcome this, the holder shown in Fig. 2 was made, in which type *A* and insert *E* are held from side play in the groove formed by milling away the tongue of the center piece, as shown by dotted lines, while screw *H* takes up end play. To change the type in the holder, Fig. 1, it was necessary to remove screws *C* and take off *B*. To change in the other holder, screws *G* are removed, when the side can be taken off leaving the type and insert free. With this holder an average of 750 impressions, of from 2 to 25 letters and figures each, are made daily on annealed tool steel. With three sets of figures and an alphabet, the range is very large, and can be increased at a fraction of the cost of separate dies for each mark. Our range, at present, embraces over 200 different marks.

Muscatine, Iowa. F. P. HEBARD.

PIPE-BENDING DEVICE.

The illustration shows a pipe-bending device which will be of value to anyone wishing to bend pipe without the trouble of filling it with sand or other materials. The mandrel *E* is held on base *K* by the steel block *D*. Stop collar *F* is set and pinned on the mandrel in such a position as to allow the end of the mandrel to project slightly past the center line of swivel block *A*, which is pivoted at *B*, and rounded out for the pipe. The backing block *C*, which also fits the pipe, is set so as to allow the pipe to slide over the mandrel *E*, and keeps it from buckling while it is being drawn off the mandrel.

The pipe is shown in the illustration after having been bent at right angles. Before making the bend, the swivel block *A* is set in a position parallel with the mandrel *E*, and the end of the pipe is then placed on the mandrel. It is



Pipe-bending Device.

held to the swivel block by means of a sliding block *G* which is locked by the eccentric lock-lever *H*. After making the bend, the lock-pin *L* is pulled out, after which the block *G* and the eccentric lever *H* can be removed; the pipe may then be pulled off the end of the mandrel. R. H. M

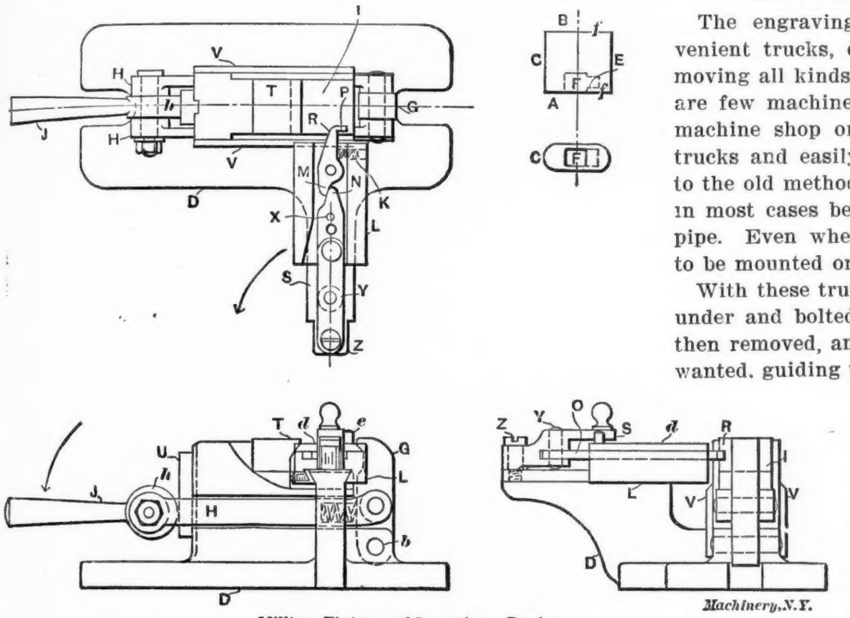
STRADDLE MILLING FIXTURE.

The accompanying engraving shows a fixture which was designed to straddle mill the casting shown in the upper right-hand corner. It was required that the piece should be finished on the two ends *A* and *B*, and that these ends should be approximately square with the side *C*, which is rough. It was important that the top surface *A* should be a certain distance from the side *E* of the cored hole *F*, and that the length from *A* to *B* should be kept constant. It was decided to use a hand miller for the operation, finishing one piece at a time.

The fixture consists of a base *D* of cast-iron, planed off on the bottom, and having a key to fit the slot in the milling machine table and holes in the ends for the usual holding down bolts. The flat side of the work rests on the hardened tool steel plate *I*, and the side *C* is pressed against the jaw *T* by the clamp *G*, thus locating the work square with the cutter spindle. The work is held down by the action of the beveled surfaces of the jaw *T* and the clamp *G*, acting on the upper round corner of the work. The clamp is pivoted at *b* to the

base of the fixture, and is operated by the eccentric h through the two connecting rods H which are attached one on each side of the clamp. The base is cut away to allow clearance for these connecting rods, and the hardened tool steel plate U is let into the back of the base for the eccentric to work against. The side plates V are fastened to the sides of the base to keep out the dirt. A coil spring forces the clamp G away from the work when the eccentric is released.

To keep the distance between E and A of the work constant, it is necessary to gage from the surface E, and the locating piece must enter the hole F, which is less than 7-16 inch square. The locating piece must also be withdrawn a sufficient amount after the work is properly located and clamped, in order to clear the cutter. The edge P of the locating piece R, which is pivoted to the slide L, rests against the surface E of the work. The slide L is dove-tailed on the bottom to fit the base of the fixture. One end of the lever O is pivoted to the slide at X, and the other end to the center Y of the arm S. This arm S is pivoted at one end Z to the base of the fixture, and has a small knob in the other end to serve as a handle.



Milling Fixture of Ingenious Design.

The plate d is placed over the slide to keep out the dirt and also carries the stud e to limit the movement of the arm S. A small coil spring K keeps the end M of the locating piece R in contact with the lever O.

To operate the locating mechanism which is illustrated in the position in which it is just at the time the work is clamped, the arm S is turned 90 degrees to the left in the direction of the arrow. This moves the end of the lever O, pivoted at Y, to the left, and the opposite end N of this lever to the right. By the action of the coil spring K on the locating piece R, the end M follows N to the right, and the opposite end P moves to the left away from surface E into the square opening of hole F of the work. The action of the arm in moving through an arc of 90 degrees also pulls back the slide, since the lever O is pivoted to it. When the arm S moves through the first few degrees, the slide has no appreciable backward movement, while the lever O has a comparatively large movement at the end N to the right. This difference, caused by the location of the pivot points of the moving parts, is such that the end P of the locating piece is first moved to the left, away from the surface E, into the square opening of hole F of the work, before the slide starts back. The latter part of the movement of arm S pulls back the slide enough so that part R will clear the cutters.

In locating the piece, the opposite action, of course, takes place; the first part of the movement of the arm causes the slide to advance, and the last few degrees movement causes it to remain practically stationary, while the end P of the locating piece R is moved to the right. With the locating mechanism withdrawn and the clamp G loosened, the operation is as follows: The work is laid on the plate I and up against the jaw T and held there with the left hand, while with the right, the arm S is swung through an arc of 90 degrees to the position in the engraving. The work is then moved until the surface E comes in contact with the locating piece, and the operator, with his right hand, throws the eccentric lever J downward in the direction of the arrow, which causes the clamp G to grip the work tightly, thus holding it down, and holding side C square with the cutter. The arm S is swung in the direction of the arrow, pulling the locating mechanism out and away from the work. The table is fed towards the cutters in the usual manner.

In operation, this jig proved to permit very rapid manipulation, and the quality of the work was all that could be desired.

Orono.

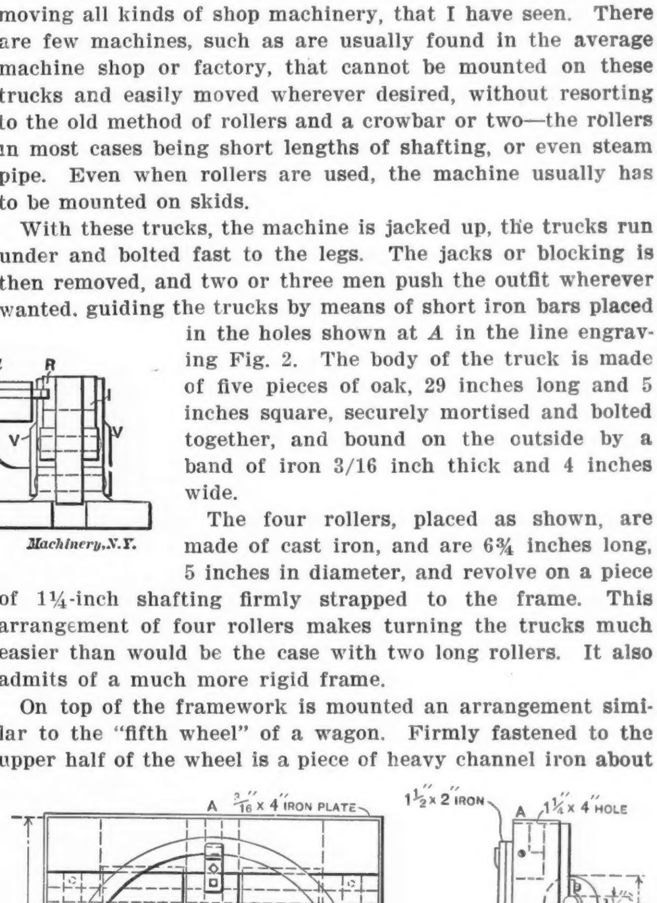
TRUCKS FOR MOVING MACHINERY.

The engraving, Fig. 1, illustrates one of the most convenient trucks, or "dollys," as the shop men call them, for moving all kinds of shop machinery, that I have seen. There are few machines, such as are usually found in the average machine shop or factory, that cannot be mounted on these trucks and easily moved wherever desired, without resorting to the old method of rollers and a crowbar or two—the rollers in most cases being short lengths of shafting, or even steam pipe. Even when rollers are used, the machine usually has to be mounted on skids.

With these trucks, the machine is jacked up, the trucks run under and bolted fast to the legs. The jacks or blocking is then removed, and two or three men push the outfit wherever wanted, guiding the trucks by means of short iron bars placed in the holes shown at A in the line engraving Fig. 2. The body of the truck is made of five pieces of oak, 29 inches long and 5 inches square, securely mortised and bolted together, and bound on the outside by a band of iron 3/16 inch thick and 4 inches wide.

The four rollers, placed as shown, are made of cast iron, and are 6¾ inches long, 5 inches in diameter, and revolve on a piece of 1¼-inch shafting firmly strapped to the frame. This arrangement of four rollers makes turning the trucks much easier than would be the case with two long rollers. It also admits of a much more rigid frame.

On top of the framework is mounted an arrangement similar to the "fifth wheel" of a wagon. Firmly fastened to the upper half of the wheel is a piece of heavy channel iron about 4 inches wide, with a channel 2 inches deep. On top of this, two pieces of iron, ½ inch thick, 5 inches wide, and 10 inches long, with slots in them 6 inches long, are riveted. Blocks of hardwood, with slots to correspond to those in the plates, are fitted into the channel. The rivets, running through these blocks, prevent the bending of the plates where the slots weaken them, and also make a much more solid job with little additional weight. The slots in the plates allow the bolts, which are inserted from below, to be adjusted to accommodate different widths of legs. The wood blocks are slotted all the way out on the inner ends so that the bolts may be taken entirely out, if necessary.



Figs. 1 and 2 Truck for Moving Machinery.

Ethan Viall.

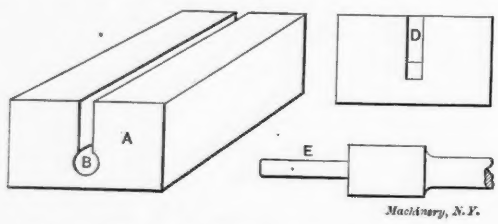
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A DRILLING KINK.

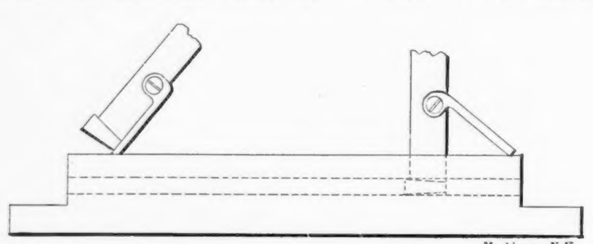
We had a number of pieces similar to *A* in the engraving below to machine with a slot having a round bottom or hole *B* through the entire length. No milling machine was available for the job at the time. The slot had to be somewhere near central with the hole, and this is the way we did the job. The block was first planed square all over, then a



slot was planed out to the proper depth. Piece *D* was set in the slot as shown to form a square hole and act as a guide for the long pilot *E* of the counter-bore. The four sides of the square hole, one of which was formed by the inserted piece *D*, guided the counter-bore central with the slot and at the right distance from the bottom of block. In this way we did a very satisfactory job. E. S. Wheeler.

LATCH FOR LIFTING PLANER TOOLS.

Every machinist knows that when planing T-slots the tool has to be blocked or else lifted on the return stroke. The former process is hard on the cutting edge, and if the clapper be a heavy one, the latter is tedious for the planer hand, with the ever-present risk of a momentary lack of vigilance on his part and the resultant ruined tool or work. To obviate both

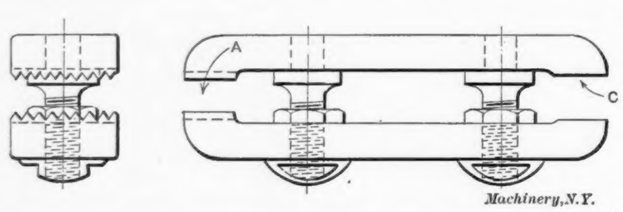


blocking and lifting the tool, I made some latches, as shown in the engraving, and applied them to the slotting tools. They need no explanation, and can be used wherever the work permits the tool to swing clear at each end. For a case wnere the slight rubbing of the latch on the return stroke is undesirable, a pad of fiber is put on with two number 0 screws. Donald A. Hampson.

Middletown, N. Y.

A HANDY SCREW THREAD GAGE.

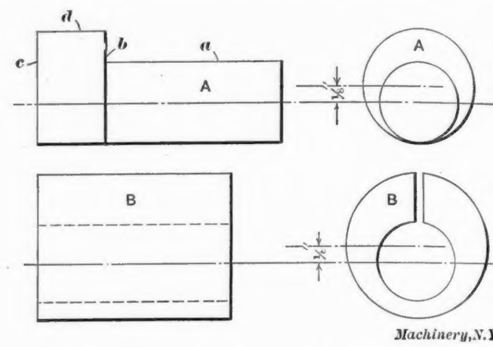
When cutting threads on screws and bolts, whether by threading dies or in a lathe, much time is wasted by gaging the threads with either a nut or a ring thread gage of the ordinary type. In the case of a piece held between lathe centers, in order to gage the thread with the ring gage, it is



necessary to remove the piece from between the centers. The Dresdner Bohrmaschinenfabrik A.-G., Dresden, Germany, is making a gage for measuring the threads of screws, which serves the same purpose as a ring gage, but saves the user considerable time. This gage is shown above. The end marked *A* fits over the threads, and the end marked *C* is supposed not to pass over the threaded screw, when threaded to the right size. Thus, not only can the size of the threads be tried, but at the same time the gage acts as a limit gage. Oskar Kylin.

TURNING AN ECCENTRIC.

The job shown at *A* below, is one which I have to do quite often, and the following is the best way I have found of doing it. First I made a split collar *B*, the outside diameter of which was turned to fit a collet chuck. In making

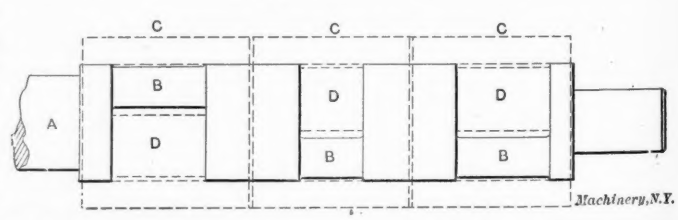


the eccentric, a piece of steel ⅛ inch larger than the finished size is used. This is chucked in a three-jawed chuck with about ⅛ inch throw, and the end *a* turned to finished size. The side *b* is then faced, and the piece is cut off, allowing enough to finish the face *c*. The piece *A* is then inserted into the hole in the collar *B*, which is held in the collet chuck, and the surfaces *d* and *c* finished. Original.

ONE WAY OF DOING A DIFFICULT JOB.

A rush order came to our department for a dozen shafts such as shown in the illustration. The immediate hurry, combined with the doubt that the order would ever be duplicated, made it imperative that some method should be devised to make them right away, regardless of whether or not a little more time and thought would enable us to do the work in a way more satisfactory in the long run. The additional tools we had to make cost so little and worked so well, that I think a description of how we finished the shafts will prove of interest to the readers of Machinery.

The shafts *A*, which were 8¼ inches over all, were first laid out with care, with two of the crank-pins *B* directly opposite the third one. The larger part of the shaft was finished to 15/16-inch diameter, and the crank-pins *B* turned to 5/16-inch diameter. The latter were first roughed out as much as they would stand without supports, and then the shafts were all finished to size. Here is where our special tools came in. These consisted of four tool-steel bushings nicely reamed to fit the shafts, and, in addition, three plugs of ½-inch round stock, two of which were ¾ inch, and one, ½ inch long. The three smaller bushings *C* were heated to a dull red and dipped in oil to prevent them from stretching when in use. The crank-pin on the left was first turned to size, then a plug *D* was squeezed in, and a collar, which was a nice snug fit, forced on. The relation the collar and plug have as a support for the shaft while the next crank-pin is being turned can now be readily seen. In this manner the three pins were finished, each time a collar and stud being added. When they were all turned, one large collar took the place of the three smaller ones, the plugs *D* still remaining. Then the part *A*, and the two ends, were turned. The shafts, when examined, were found to be true, besides being finished in good time considering the nature of the turning. Pedro.



SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

411. SOLDERING KINK.

When soldering, and no acid is handy, a common tallow candle will answer the purpose. JOHN B. SPERRY.

Aurora, Ill.

412. CHALK PREPARATION FOR TRACINGS.

Mix thoroughly one pound of pulverized chalk with one-quarter pound of borax. Rub some of this mixture into a chamois skin, and rub the tracing carefully with this. This preparation is superior to pure chalk. REX MCKEE.

Joliet, Ill.

413. MARKING FLUID FOR BLUE-PRINTS.

The following receipt for marking fluid for blue-prints has given me satisfaction. The fluid is composed of potassium oxalate, 1 ounce; gum arabic, 1 dram (60 grains); water, 6 ounces; cobalt-blue to color.

Staten Island, N. Y. WILLIAM H. DAVID.

414. CEMENT FOR ARC LAMP CARBONS.

The short ends of old arc lamp carbons may be cemented together to form rods which burn quite well, and are no more brittle than ordinary carbons. The cement required is made by mixing potassium silicate and carbon dust to a consistency of a thick paste. The ends of the short carbon pieces are faced off square, and, after application of the paste, are pressed together by hand. O. G.

415. USEFUL SALVE.

While a great many shops now have facilities for attending to shop accidents, the necessity is often felt by the mechanic working in a small shop, or outside, for a useful salve to be applied to wounds in case of accident. The writer has made the following salve himself, has used it, and knows that it is far in advance of most articles for sale in drug stores at ten times the price. The ingredients are as follows: Two parts of swallow oil, five parts of petrol wax, two parts eucalyptus, and two parts of beeswax. ARDEN.

416. TO REMOVE RUST FROM SMALL STEEL PARTS.

Rust may be removed from small steel parts such as screws, nuts, pins, etc., when they are not badly pitted, by dipping them into a dilute solution of sulphuric acid. To prepare the acid bath, pour the acid little by little into a bowl partly filled with water. After each addition of acid, try one of the rusted parts, and continue trying until the proper strength is obtained to eat the rust off clean. Better results will be obtained in this manner than by working to a set formula. Let the parts remain in the acid bath until cleaned of rust, then remove and wash in soda water, and then in benzine. Finally dry the parts and brighten in sawdust.

S. W. GREEN.

417. PREVENTING SERIOUS RESULTS FROM INJURIES FROM RUSTED OBJECTS.

Everyone knows how a small wound caused by rusty pieces of metal oftentimes develops blood poison, or lock-jaw. The following old-fashioned but infallible "first aid to the injured" may therefore be of value to remember. Ordinary brown sugar is heated on the surface sufficiently hot to produce a smoke, and the wound is held in this smoke for several minutes. No serious results will follow after this treatment, and all soreness will be taken out of the wound even though the application takes place some time after the accident. The smoke given off by burning woolen rags is equally effective, and, as they are more often available, particularly to a man "off on a job," to keep this simple remedy in mind may be well worth while. DONALD A. HAMPSON.

Middletown, N. Y.

418. WHITE LEAD AND TALLOW OF EVEN CONSISTENCY AT ALL TEMPERATURES.

In order to keep white lead and tallow soft in winter and summer alike, so that it can be applied with a brush to finished parts of machinery before shipping them, and for use in fitting keys, etc., prepare a mixture composed of five pounds of white lead and fifteen pounds of tallow. Heat this in a suitable receptacle, and stir until the ingredients are thoroughly mixed. Then remove the mixture to a cool place, and add two quarts of linseed oil, continuing to stir the composition until it becomes cold, as otherwise the white lead will settle to the bottom. This mixture will always remain of the same consistency at all temperatures. R. S. F.

419. ZINC PAINT FOR OIL WELLS.

Persons having occasion to paint oil wells of bearings, or any surface coming in contact with either hot or cold oil, will find a zinc paint consisting of 25 pounds oxide of zinc, 3 gallons gloss oil, and 1 quart linseed oil, cut with turpentine, and bleached with ultramarine blue, to be one of the best coverings ever made. The surface to be covered should be absolutely free of all greasy or oily substances; if proper care is taken, the paint will not crack and will retain its pure white appearance indefinitely. The paint can be blown into water jackets of bearings, filling the sand holes, and as it dries rapidly, will be found excellent for the purpose.

ELECTRO.

420. BROWN-PRINTS.

The following solution will change the color of blue-print paper to a dark brown: Borax, 2½ ounces; hot water, 38 ounces. When cool, add sulphuric acid in small quantities until blue litmus paper turns slightly red, then add a few drops of ammonia until the alkaline reaction appears, and red litmus paper turns blue. Then add to the solution 154 grains of red crude gum catechu. Allow this to dissolve, with occasional stirring. The solution will keep indefinitely. After the print has been washed in the usual way, immerse it in the above bath for a period of a minute or so longer than necessary to obtain the desired tone. An olive brown or a dark brown is the result. JOHN B. SPERRY.

Aurora, Ill.

421. BLACK FINISH FOR STEEL.

The pieces to be blackened should first be polished with No. 120 emery cloth. After polishing, the surfaces should be cleaned carefully, and then the work placed over the fire and drawn evenly to a second blue. Then, the work is dipped in lard or sperm oil, from which it is immediately removed, and all loose oil shaken off. This prevents the forming of blisters. An old piece of rubber, for instance a piece of old garden hose, is then placed on the fire, and as it burns, the work is held over the flame and smoke that comes from the rubber, until it is covered with a thick coat of black soot. The work is then removed from the fire, and permitted to cool off slowly. When cool, it is rubbed with an oiled cloth. All this must be done in one heat. E. W. NORTON.

Tarrytown, N. Y.

422. TO SAVE BURNED OR OVER-EXPOSED BLUE-PRINTS.

Blue-prints that have become burned or over-exposed, may be saved by the use of the following formula: Make a saturated solution of bichromate of potash, and keep a supply on hand in the blue-print room. If a print becomes over-exposed, wash it in the usual manner in a tank or tray of water, after which place it in another tray which should contain a mixture of two parts water to one part of the saturated solution of bichromate of potash. Allow the print to remain in the tray containing the solution until it shows a deep blue color and the white lines are clearly defined (which requires but a few seconds), after which the print should be thoroughly washed and rinsed in clear water. The proportion of the bichromate of potash may be increased or diminished as the occasion requires. This solution also acts equally as well when applied to white-prints made from vandyke negatives. Prints, as well as expense and time, may be saved by the use of the above solution. J. C. HASSETT.

Meadville, Pa.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

TESTS ON CAST IRON CYLINDERS.

J. A. J.—In testing cast iron cylinders used for dryer rolls on paper machines 48 inches diameter, 120 inches long with the heads secured by cap-screws, which is the most severe test, 100 pounds per square inch steam pressure or 100 pounds cold water pressure? 2. Is there any difference in the sizes of the molecules of steam and water?

A.—1. Theoretically the stresses imposed by 100 pounds steam pressure and 100 pounds water pressure are the same, but for the purpose of a test to determine the tightness of the joints, water pressure is to be preferred. Small leaks are easily discernible with water that would escape detection with steam. Moreover, small steam leaks soon "take up," in the parlance of steam fitters, whereas small water leaks close very slowly, the sealing depending on the rusting of the metal. Compressed air is more searching than either water or steam; it will escape through a very minute aperture, and the leaks have no tendency to seal themselves. Water pressure obtained with a pump is more severe on the structure of cast iron than steam pressure because of the water hammer due to the pump action. 2. The chemical combination H_2O exists in three forms, *i. e.*, ice, water, and steam, and it is supposed that the size of the molecule is unchanged in all three states.

MILLING SPIRALS—INVOLUTE SYSTEM OF GEARING.

J. G. I.—1. What is the method of figuring the angle to which to set a universal milling machine table for cutting a given spiral? 2. Is not the involute system for standard cut gears exclusively used?

A.—1. To calculate the angle of the spiral to be milled on a cylinder, the lead of the spiral and diameter must be known. Then the formula is:

$$\text{Tangent } a = \frac{D \times \pi}{\text{lead}}$$

in which a = angle of the tooth with the axis of the gear,
$\pi = 3.1416$,
D = diameter of piece.

For example: What is the angle of a spiral with its axis that makes one turn in 27.22 inches, the diameter being 3½ inches?

$$\text{Tangent } a = \frac{3\frac{1}{2} \times 3.1416}{27.22} = 0.40403,$$

the tangent of 22 degrees.

2. The involute tooth is the form most used in the United States for cut gearing, but it is by no means exclusive. Cast gearing is generally made with cycloidal teeth, and some users of cut bevel gears prefer the cycloidal to the involute system.

TO DRILL SMALL DEEP HOLES—SAND-BLAST FINISH ON TOOLS.

V. A. W.—1. How are oil holes drilled in the so-called oil twist drills used for deep hole drilling? The holes in the samples before me are only about 5/32 inch in diameter and about 8 inches deep. They follow the twist of the flute. 2. How is the beautiful gray color produced on drills and milling cutters that is characteristic of the product of some small tool manufacturers?

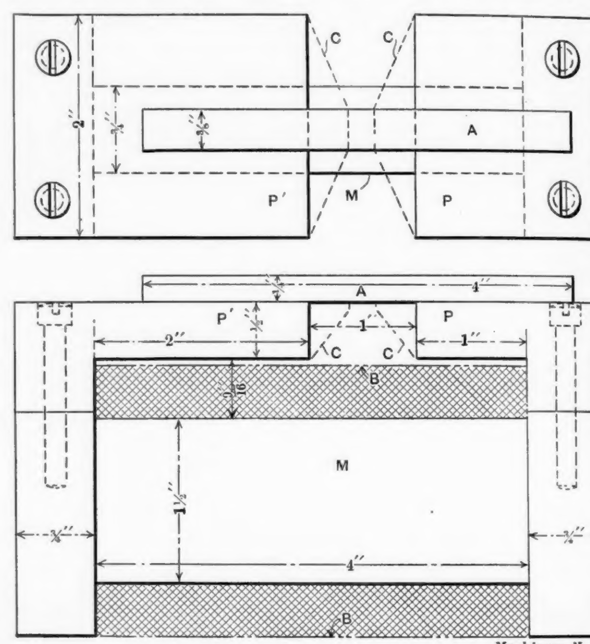
A.—1. The holes are drilled before the drill is twisted, the blanks being rough-fluted, the drill twisted, and then finished in the usual manner. The drilling of the oil holes is done progressively by small twist drills, arranged in order of length, each drill deepening the hole made by its predecessor only ½ or ¾ inch. The hole is begun with a short, stiff drill which starts the hole perfectly straight and true, and the following drills are guided by the section of the hole first drilled. This practice avoids the use of a long slender drill to drill the first part of the hole, and enables the drilling to be done much faster than would be possible otherwise. For a description of this practice in drilling small deep holes in pneumatic hammer barrels, see MACHINERY, December, 1902, page 231, engineering edition. 2. The beautiful gray color noted on twist drills, milling cutters, etc., is doubtless produced by the sand-blast process used by some makers to remove the burned oil and oxide resulting from the hardening process. It is merely incidental to this method of cleaning, but because of the beautiful, frosted surface it has a merit of its own. We believe that the same result is also obtained by electrolysis, the tools being suspended in an electric bath. The passage of the electric current removes the oxide and leaves the surface in much the same condition as that produced by the sand-blast process.

CONSTRUCTION OF A MAGNETIC CHUCK.

C. M. W.—Please give me instructions for making a magnetic chuck to hold pieces of ⅜ × ¼ × 4-inch hardened steel for grinding, etc. I wish to use the chuck on an incandescent lighting circuit, and desire to know the size of wire and the quantity required for winding the magnet.

Answered by William Baxter, Jr., Jersey City, N. J.

It would not be possible to give all the information you desire without writing an answer that would fill a book. We can say, however, that if the magnet M is made of cast-iron or wrought-iron and wound with wire up to the lines B, it will hold the steel piece A if a direct current is passed through the wire. The force with which A would be held against the poles PP' would depend upon the kind of metal, the number of ampere turns of magnetizing current flowing around M, the distance between the ends of P and P', their



Machinery,N.Y.

shape, and the general conformation of the whole structure. The ampere turns are obtained by multiplying the number of turns of wire in the magnetizing coil, by the current strength in amperes. The force with which the poles P P' will hold the bar A is determined by the aid of the simple formula:

$$F = \frac{AB^2}{72{,}000{,}000},$$

in which F is the tractive force in pounds, A is the area of contact between bar A and the poles PP' in square inches, and B is the magnetic density in lines of force per square inch passing through the surface of contact. To find the force with which A is held, all that is necessary is to know the magnetic density B. The way in which this is found we cannot give briefly, but you can find it in any good book on electrical engineering. If M is made of wrought iron, the pull will be about three times as great as with cast iron, other things remaining equal. If the ends of PP' are shaped as indicated by the dotted lines C, the pull will be further increased. You could wind the coil with No. 20 B. & S. gage magnet wire, and connect it in series with four or five 16-candle lamps; that is, connect so that the current passes through the lamps and then through the coil. If the wire does not get dangerously hot, and the magnet is not strong enough, connect more lamps in the group, putting the second lot of lamps in parallel with the others.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

A LINE OF ATTACHMENTS FOR THE LEBLOND MILLING MACHINES.

The R. K. LeBlond Machine Tool Co., 4609 Eastern Avenue, Cincinnati, Ohio, builds a line of milling machines which is well known to the readers of MACHINERY. To extend the usefulness of these milling machines over as wide a range of work as possible, the builders have designed a very complete and ingenious line of attachments. We show herewith halftones and line drawings of these various attachments, together with numerous illustrations showing their application to general shop work.

Worm and Spur Gear Hobbing Attachment.

The device shown in Figs. 1, 2 and 3 is designed particularly for the hobbing of worm-gears, but, as will be explained later, can be used for spur gears as well.

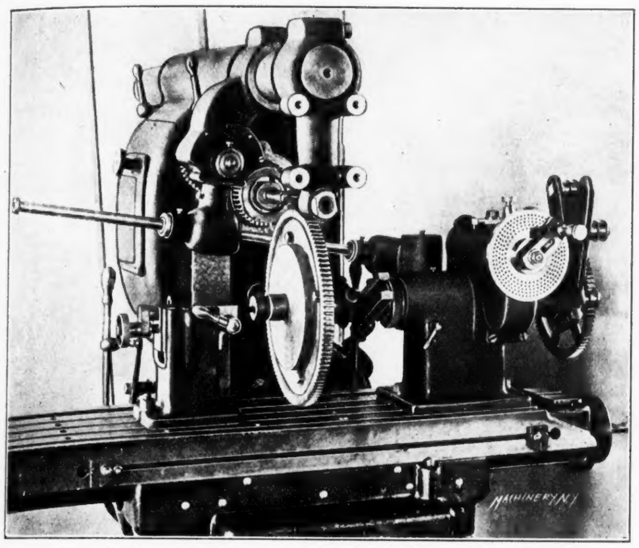


Fig. 1. Hobbing Attachment for the LeBlond Milling Machine Cutting a Large Worm-wheel.

The head- and foot-stocks of this arrangement are those of the builder's standard plain dividing head, the attachment itself consisting of means for connecting (through the index worm or directly as required) the spindle of this dividing head by change gears with the spindle of the machine, in such a way as to give the required ratio of rotation between the hob and the wheel. This connection is made through a

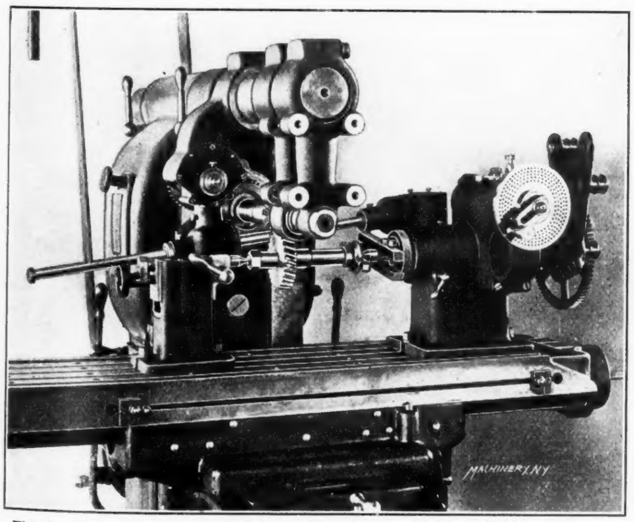


Fig. 2. Cutting a Small Worm-wheel with the Change Gearing Directly Connected to the Work Spindle.

flexible transmission system consisting of bevel gear joints and a splined shaft, which permits absolute freedom of adjustment between the index head and the spindle. On the threaded nose of the latter is screwed a spur gear, meshing with a corresponding gear on a short spindle, supported by a bracket clamped to the over-hanging arm of the machine. This short spindle carries a bevel gear meshing with a mate keyed to a short vertical shaft from which the splined shaft is driven, through another pair of bevels. The connections from these through to the back side of the head can be readily followed by comparing Figs. 1 and 2, where the machine is shown in two different adjustments, to each of which, as will be seen, the arrangement readily adapts itself.

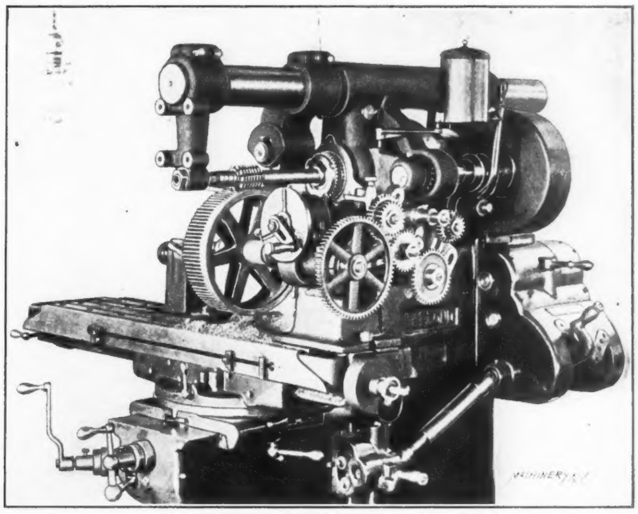


Fig. 3. Hobbing a Spur Gear with the Hobbing Attachment on a Universal Milling Machine.

The quadrant carrying the change gears for obtaining the desired ratio between the cutter and work spindles is best seen in Fig 3. The driving connections are so arranged that the driving shaft from the change gears can be connected either directly to the spindle for cutting wheels of few teeth, or through the indexing worm and worm-wheel for large numbers of teeth. In Fig. 1 the attachment is set up for hobbing a worm-wheel having many teeth, so the connection is made

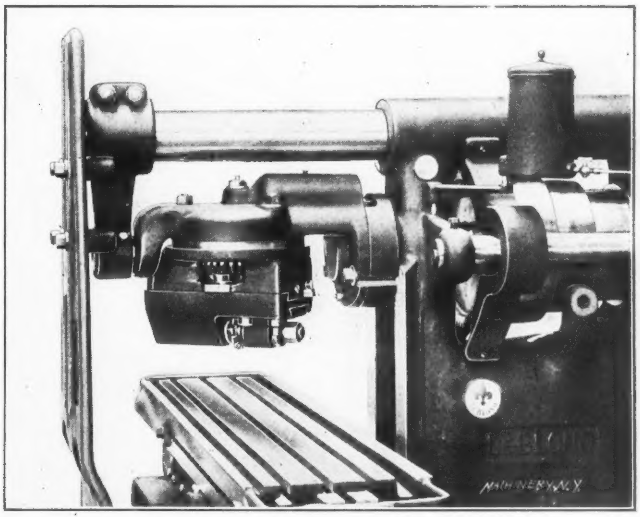


Fig. 4. Universal Spiral Gear Cutting Attachment.

through the index worm of the dividing head. In Fig. 2, on the contrary, a worm-wheel of few teeth and for a multiple threaded worm is being hobbed, so the ratio of rotation is too high to be conveniently transmitted to the worm gearing. Under these conditions the change gearing is attached directly to the work spindle.

The advantages of the positive method of hobbing worm-wheels are well known. The positive connection between the wheel and the hob makes unnecessary the preliminary gashing of the former, and so materially reduces the time and cost of doing the work. In some cases it may be done in from one-fourth to one-fifth of the time required for the method which combines gashing and hobbing on a freely running work spindle. A very fine feed is provided, and the work can

be fed into the hob automatically and tripped when the teeth have been cut to the proper depth.

The worm-wheel shown in Fig. 1 has 120 teeth, 0.390 inch circular pitch, and is a trifle over 15 inches in diameter. The coarse pitch worm-wheel in Fig. 2 has 26 teeth, 6 pitch, quadruple thread, and is 2 5/8 inches diameter. This gives a ratio of 6½ to 1, requiring the change gearing to be connected direct to the spindle, as explained. The gears are hobbed complete in 12 minutes apiece, with power feed.

Perhaps the most interesting use of this attachment is for the cutting of spur gears by the hobbing process. This process has been previously described in MACHINERY,* and the principle of its operation fully explained. It requires simply that a suitably shaped hob be rotated in the proper ratio with a spur gear blank, and fed through it at a suitable speed, the hob being set to cut teeth to the correct depth. The hob must also be set at the helix angle of its thread, as measured on the pitch line, if it is to give the proper shape to the teeth of the gear. It will be seen that this attachment, as described and shown in Figs. 1 and 2, furnishes the required movements and adjustments, except for the setting of the hob at the helix angle. To accomplish this, it is only necessary to use the device on a universal machine, as shown in Fig. 3, bringing the table around so that the work and the hob are in the proper angular relation to each other. Under these circumstances, with the hob set at the proper depth and the proper change gears mounted in place, the hob may be started at one edge and fed through, finishing the work complete at one passage. This method of cutting spur gears has the well-known advantages of cutting all numbers of teeth for a given pitch with a single hob, and of giving a large output, owing to the fact that the cutting action is continuous, and does not require the return of the cutter and the indexing of the blank, as is required by the usual method of performing this work on the milling machine or automatic gear-cutter.

A set of compound gears is furnished for reducing the feed in the ratio of about 20 to 1. The reason for requiring this very fine feed is that the advance of the cutter per revolution should be in proportion to the number of teeth of the gear. For instance, in cutting a spur gear with 60 teeth, if we wish to feed the work past the cutter at 0.060 inch per revolution of the work, it will be necessary to set the feed to equal 1/60 of this amount or 0.001 inch, per revolution of the cutter.

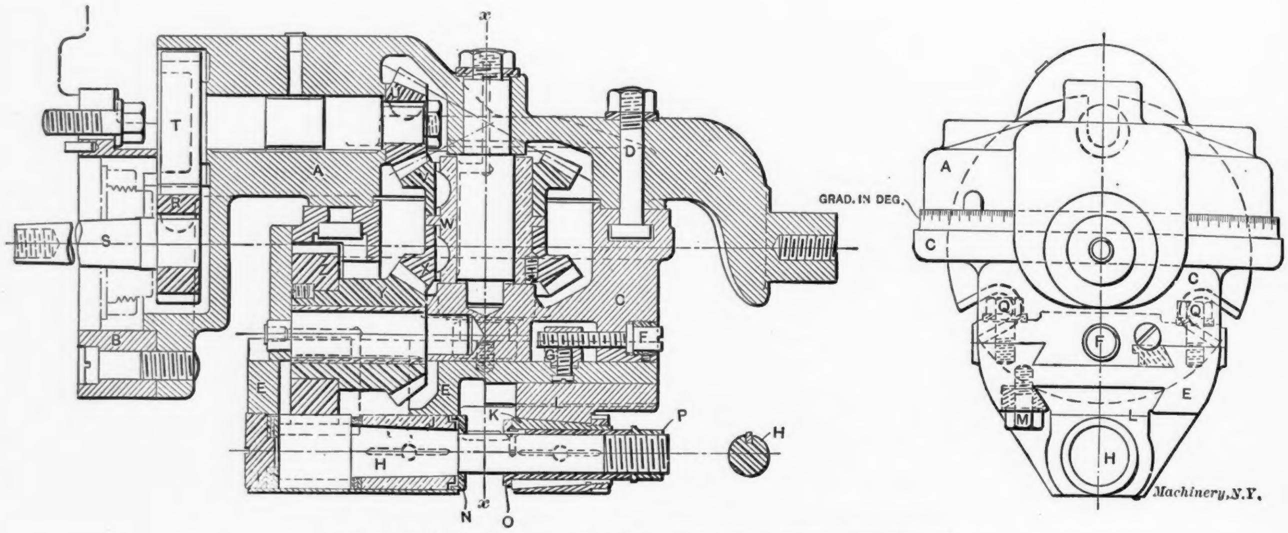


Fig. 5. Details of Construction of the Spiral Gear Cutting Attachment.

The spur gear being hobbed in Fig. 3 is 8 pitch 102 teeth. The capacity of the device is for work up to 16 inches in diameter, the spur gears and worm-gears alike.

Universal Spiral Gear Cutting Attachment.

There are two noticeable points of difference between the universal spiral gear cutting attachment shown in Fig. 4, and most other attachments which have been built for the same purpose. One of these differences is the fact that in this case the cutter is mounted so that it can be centered on the vertical axis about which the angular adjustment is effected. This being the case, the work may be centered with the cutter, which is then swiveled to any angle desired throughout the whole 360 degrees, without requiring recentering. The other feature of the construction, plainly evident in Fig. 4, is the manner in which the supporting head of the device has been off-set vertically, so as to raise the cutter nearer the center line of the spindle, and thus increase the maximum vertical distance obtainable between the top of the table and the bottom of the cutter. If it were not for this offset and for the change in the method of driving required by it, the capacity of the machine under the cutter for work mounted on the table or on centers, would be materially reduced.

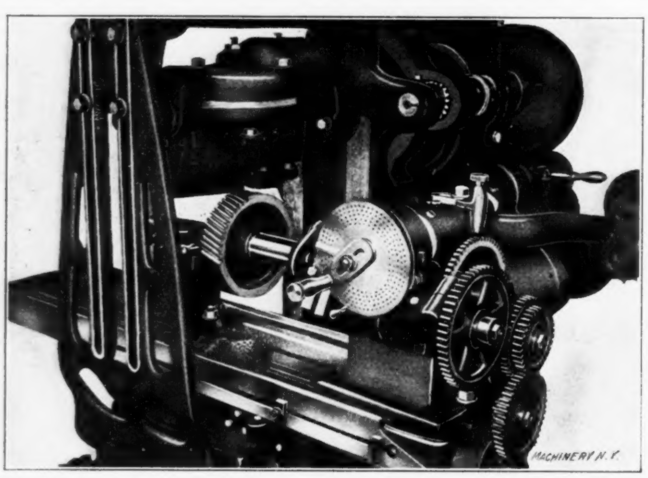


Fig. 6. Cutting a Spiral Gear of Large Diameter and Large Lead.

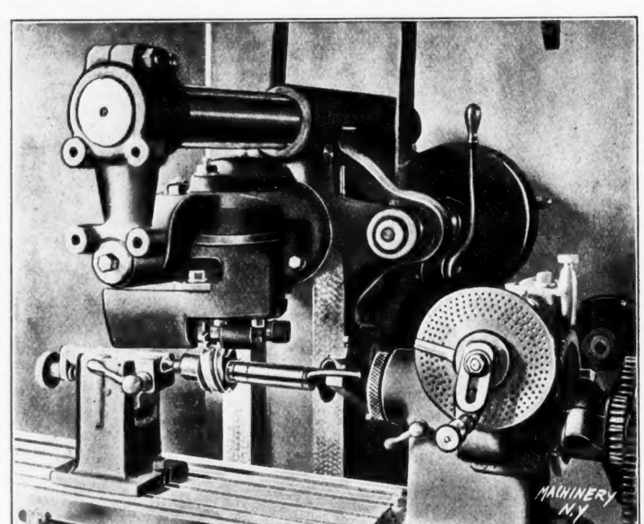


Fig. 7. Cutting a Spiral of Short Lead on the Plain Milling Machine, an Operation Impossible on the Universal Machine without Special Attachments.

* See article entitled Gear-Cutting Machinery, March, 1908, issue of MACHINERY.

The mechanism of this device is best understood by reference to Fig. 5. The body A of the device is clamped, through collar B, to the front of the column at the end, and is provided at the other, or outer end, with a bearing entering the hole in the outer support for the arbor (see Fig. 4). The attachment thus does not have to depend entirely on its own rigidity in supporting the cutter, but has the additional stiffness of the over-hanging arm to depend on. To A is clamped

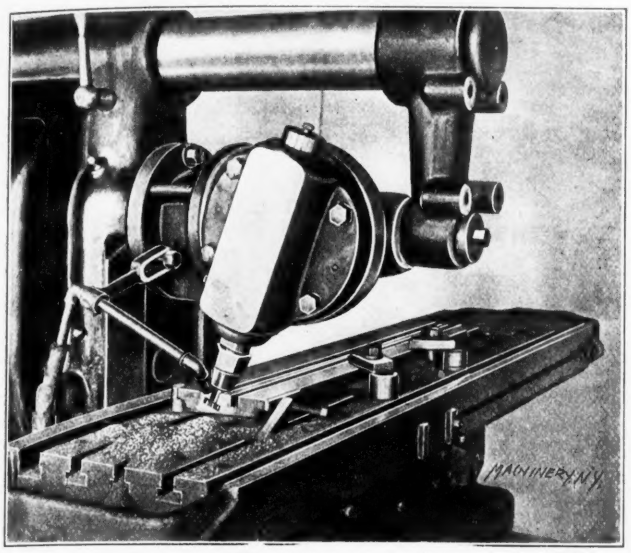


Fig. 8. The Universal Milling Attachment cutting an Inclined Slot.

the swivel base C, by means of bolts D entering a circular T-slot in its outer face. This arrangement provides for the adjustment of C to any angle throughout a full circle about the vertical axis xx. It is centered on its seat in A by means of the internal shoulder shown. The exterior surface, as seen at the right, is graduated in degrees to indicate the setting obtained. Dovetailed to C on horizontal guides is the spindle head E. The adjustment along the slide is effected by shoulder screw F, seated in C, and nut G, clamped to E. This adjustment provides for the centering of the cutter on xx, the axis of angular adjustment.

The main bearing of the spindle H is tapered $\frac{5}{8}$ inch to the foot, and runs in a bronze bearing J, fast in head E. An outboard bearing K is also provided. This is tapered and is drawn by the nut shown into a taper seat in the removable

The drive is taken from the main spindle of the machine through a pinion R, keyed to a taper shank S, driven into the spindle hole. This meshes with a gear T, which has a shaft integral with it journaled in casting A, and carrying keyed to it at its outer extremity bevel pinion U. This pinion meshes with bevel gear V, keyed to bronze sleeve W, to which is also keyed another bevel gear X. This sleeve revolves on the stud about whose axis the angular adjustment of C on A takes place. Bevel gear X mates with bevel gear Y, which is bronze bushed and revolves on a stationary stud. On the shank of Y is doweled gear Z, which engages pinion teeth cut at the left-hand end of spindle H. The teeth of H are made of sufficient length to provide for the longitudinal adjustment of the head E when centering the cutter. It will be seen from the end view that the bottom of the spindle head is flattened off as close as possible to the outside diameter of the driving pinion, so that the cutter may project beyond all parts of the attachment far enough to do such work as rack cutting, if required.

Two examples of the use of this attachment are shown in Figs. 6 and 7; in both of these cases a plain milling machine is used in combination with the same plain indexing head to

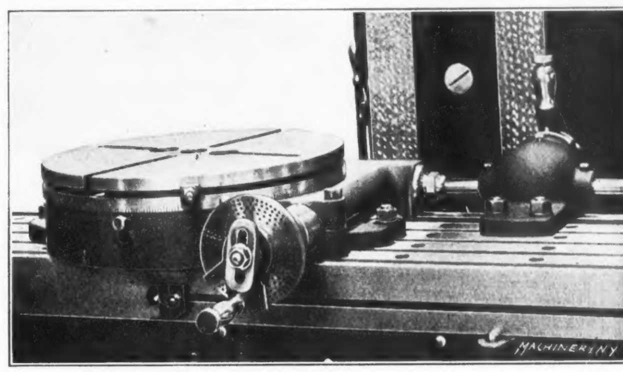


Fig. 10. Circular Milling Attachment with Automatic Feed and Throw-out.

which the hobbing device is shown attached in Figs. 1, 2 and 3. This combination of plain index head and spiral gear cutting attachment converts the plain milling machine into one of the universal type. In Fig. 6 a spiral gear of large diameter and small helix angle is being cut, so the head is set at but a slight angle from a position parallel with the spindle of the machine. As may be seen, the head is connected by change gears with the table feed screw, the same as for the universal arrangement. In Fig. 7 the attachment is shown

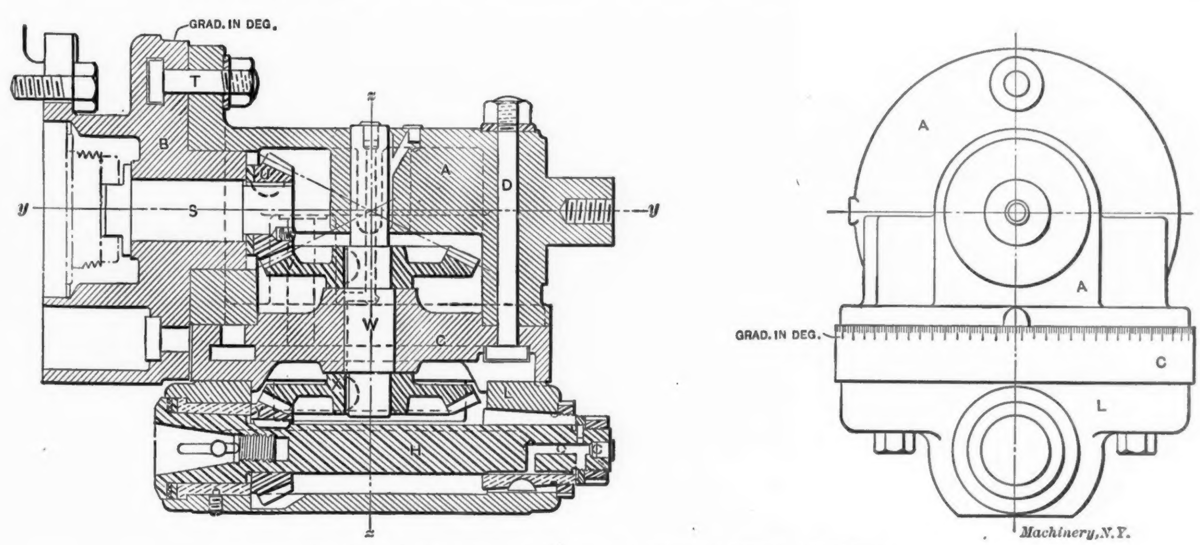


Fig. 9. Details of Construction of the Universal Milling Attachment.

bearing support L. This bearing, which is thus adjustable for wear, is removed bodily with L when changing cutters. For this purpose L is mounted in a dove-tail slide on the under side of spindle head E, being clamped there by bolt M. The cutter is clamped between collar N and the flange on sleeve O, which latter is pressed against the cutter by nut P at the outer end of the spindle. For locking the horizontal adjustment of E, used for centering the cutter, bolts Q and Q are provided.

performing work which the universal milling machine is incapable of doing except with special appliances. This work is the cutting of spiral gears of such large helix angle (or, in other words, of such short lead) that it would be impossible to swing the table through the required angle, thus necessitating the use of a right angle drive for the spindle, or the doing of the work with the vertical milling attachment. The possessor of the plain indexing device and this spiral gear attachment, therefore, is in some respects better equipped for

spiral work than if he had a milling machine of the universal type. He is not, of course, able to do either indexing or spiral cutting on taper work, but otherwise he is provided for. This attachment may also be conveniently used for thread milling.

Universal Milling Attachment.

The universal milling attachment shown in operation in Fig. 8 and in detail in Fig. 9 is of something the same construction as the spiral gear cutting attachment, though it is built for a wider range of work, and so differs in the details of its construction. As may be seen in Fig. 8, the cutter is mounted in a taper hole at the end of the spindle, instead of centrally between two bearings, as in the previous attachment. No end movement is provided for the spindle, and there is no necessity for keeping the distance from the center line of the spindle to the face of the spindle bearings down to a minimum, as the work required of the device is mostly in the nature of end milling, or other operations in which this clearance is not vital. These considerations simplify the design of the device. An additional movement is provided, however: an adjustment at any angle throughout the whole circle, about the axis of the main spindle of the machine.

In Fig. 9, *A*, the main body of the device, is supported at the outer end by the over-hanging arm as in the previous case, while at the other end it is fastened to a flange *B*, which is in turn made fast to the face of the column. Bolts *T*, entering the circular T-slot in *B*, provide for clamping body *A* in any angular position about axis *yy* of the machine. Swivel plate *C* is clamped to *A* by bolts *D* entering the T-slot in the former, so that the spindle head L, which is fastened to *C*, may be adjusted at any desired angle about axis *zz*. Graduations in degrees are provided for both of the swivel movements with which the spindle is thus provided.

The device is driven by a short shaft *S*, having a tongue on its inner end entering the slot cut in the nose of the spindle. Bevel gear *U*, keyed to the outer end of *S*, engages bevel gear *V* keyed to shaft *W*, which latter is journaled in body *A* and swivel base *C* of the machine. The lower end of *W* has keyed to it bevel gear *X*, meshing with bevel gear *Y* on the spindle, which is thus revolved at the same rate of speed as the main spindle of the machine. It will be seen that the drive is simpler than in the case of Fig. 5, partly because the offset to give increased working range in the device is not required, and partly because the drive of the spindle is less restricted, so that a direct bevel gear drive may be used in place of the spur gearing of the previous attachment. The spindle *H*, shown in Fig. 9, is provided with a special taper for a collet with a threaded shank. It will also be furnished with a regular No. 7 Brown & Sharpe taper having a hole for a through bolt, to be used in drawing the taper shanks to their seats or ejecting them for removal.

In Fig. 8 the attachment is shown engaged in milling an angular T-slot, the work shown being the table of the cutter and reamer grinder built by the same firm. Other operations for which it is adapted are for such a variety of work as drilling, key-seating, and milling of spirals of too great an angle to be done with a cutter driven directly by the main spindle of the universal milling machine. Special conditions are readily met, the device often obviating the necessity for angular mills, since the spindle can be swiveled to any angle of the horizontal or vertical plane. It will be noted that the

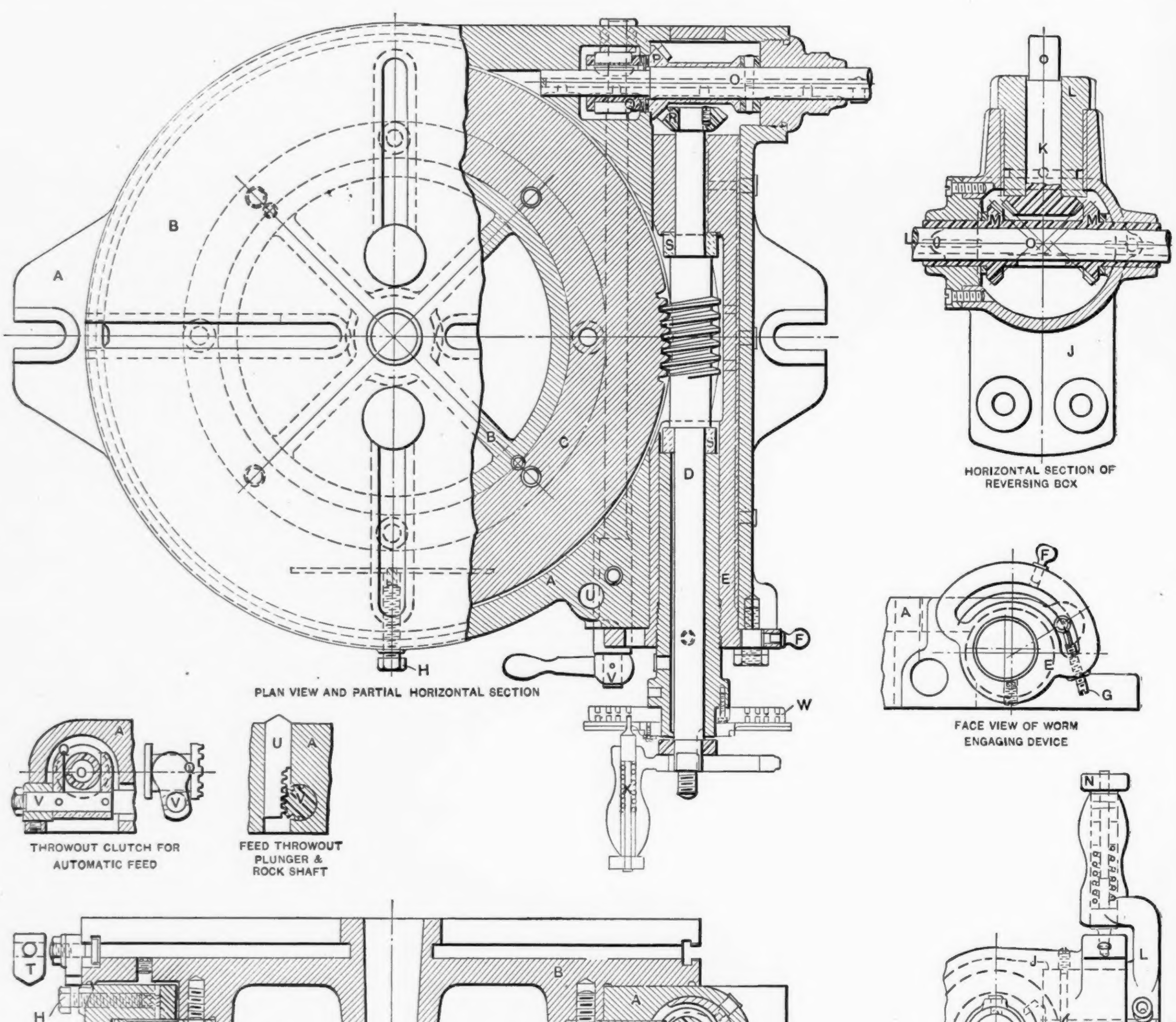


Fig. 11. Details of Construction of the Circular Milling Attachment and its Feed Connections.

front bearing is tapered ⅜ inch per foot, with a hardened and ground journal. The rear bearing is straight, and is adjusted by drawing in the split taper bushing.

Circular Milling Attachment.

Fig. 10 shows a circular milling attachment with automatic feed and throw-out, which is adapted to be used especially with a vertical attachment such as shown in Fig. 12, for the finishing of all kinds of cylindrical surfaces, on work which can be conveniently held on a circular table.

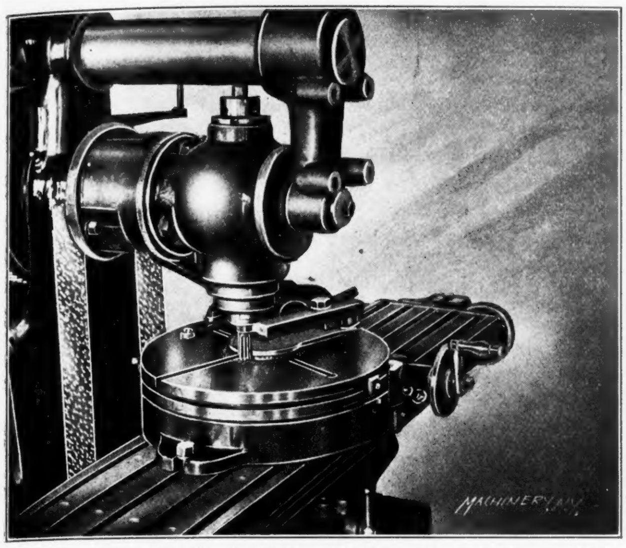


Fig. 12. Use of the Circular Milling Attachment in Finishing Straight and Circular Surfaces.

The details of this device are shown in Fig. 11. The circular base of the device, *A*, is clamped to the milling machine table. Table *B* rests on base *A* and is centered with it by a circular rib which closely fits a machined circular opening in the top of *A*. To a seat in this circular rib is clamped worm-wheel *C*, which, in combination with worm *D*, forms the means for revolving the table, and at the same time serves as a gib for drawing *B* down to its bearing on *A*. The center of *B* is provided with a tapered socket for convenience in holding arbors or studs for centering work, and other special uses. The extended hub provided for this taper hole is connected by ribs with the body of the table, so as to make the whole very rigid, and able to resist distortion due to the clamping of the work on its upper surface, without cramping the table on its guiding surface.

Worm *D* may be operated by a crank and index plate at the outer end, of the same kind as used on the builder's standard

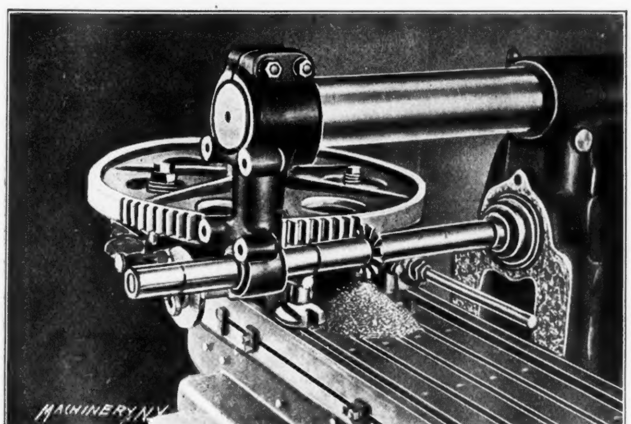


Fig. 13. Using the Circular Milling Attachment as an Indexing Device for Cutting a Large Gear.

dividing head, thus permitting the dividing of work clamped to the table with the same facility. Graduations in degrees are also provided on the outside diameter of the table, so that angles may be conveniently laid out without the use of the index plate. For a quick movement of the table, the worm may be thrown out by an eccentric device, not shown in Fig. 10, but incorporated in the later design shown in the line engraving, Fig. 11. This consists of an eccentric sleeve *E* in which the worm and worm shaft are mounted. By rocking this by means of knob *F*, the worm may be thrown into or out of engagement at will. A stop screw *G* on the sector flange of the eccentric limits the inward movement to give the proper amount of play to the worm, and a clamp nut at the same point furnishes means for retaining it in either the in or out position. A set-screw *H*, at the front of the base, bears against a thin strip of the bearing of the table, which has been separated from the remainder of the base by the saw cut shown. This provides means for clamping the table in position while the cut is being taken, either for the rapid indexing with the worm thrown out, or for hand indexing through the worm and dividing plates.

The power feed for the device is obtained from the gear box without interfering with the regular transverse, cross, and vertical feeds, so that either of these may be used on the pieces without having to be disconnected for the circular feed. This makes it possible to finish very conveniently parts that have both plain and cylindrical surfaces to be milled. A telescopic feed rod is provided, leading from a shaft held in a bracket on the side of the column of the machine, and connected by chain and sprocket wheels with the shaft on the feed box. This telescopic shaft is connected with reversing gear box *J*, clamped on the milling machine table. The bevel gear and its shank *K* to which the telescopic shaft is pinned

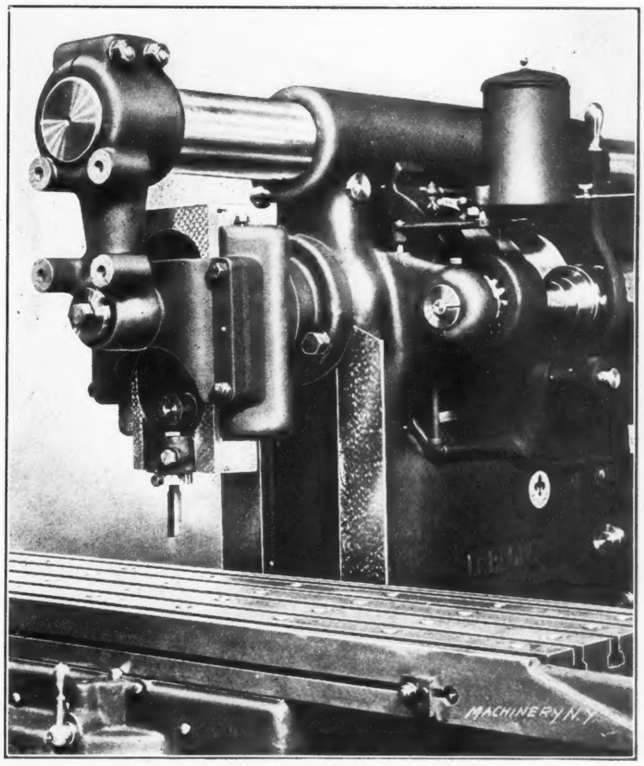


Fig. 14. Attachment for Slotting in the Milling Machine.

are seated in an eccentric bushing *L*, which may be rocked by means of lever *N*. Feed shaft *O* leading from the circular attachment, passes through reversing box *J* and is keyed to sleeve *M*, on which are formed a pair of bevel gears. The drawing shows lever *N* in its central or vertical position, in which bevel gear *K* is out of mesh with the gears on sleeve *M*. By throwing lever *N* to one side or the other, eccentric sleeve *L* is rocked and bevel gear *K* is thrown into engagement with one or the other of the two bevel gears *M*, thus giving motion in either direction to feed shaft *O*, as required.

Shaft *O* is connected with bevel gear *P* by means of clutch *Q*, which is operated by a long rock shaft *V*, connected with a handle at the front of the base. By means of this handle, the automatic feed is stopped and started. Bevel gear *P* meshes with a mating gear *R* on worm-shaft *D*, thus completing the connection required for the automatic feed. *S* and *S* are ball bearings to take the thrust of the worm, thus making the operation of the feed easy even under the heaviest cuts. For cases in which the indexing is not required, a hand-wheel is used on the upper end of shaft *D* in place of the index crank, thus making either the power or hand operation of the device equally easy. The periphery of the circular table

is provided with a T-slot in which is clamped adjustable tripping dog T, which may be set to depress plunger U at any desired point, thus rocking rod V and automatically throwing out the feed.

The design of the device is very compact so that the vertical capacity of the machine is not unduly reduced by its use. Figs. 12 and 13 show two examples of its use. In the first case a piece of work which requires both straight and

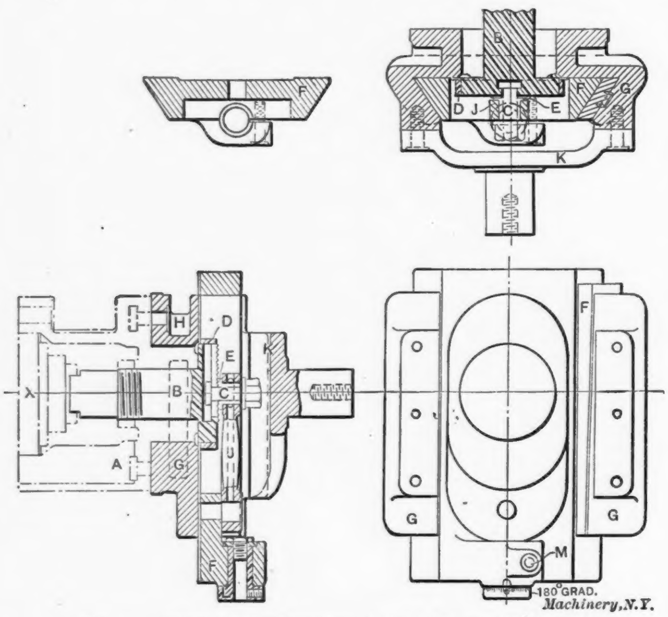


Fig. 15. Details of Construction of the Slotting Attachment.

circular milling is clamped to the table, giving a good opportunity for the use of longitudinal and circular feeds in succession, as provided for by the independent connections previously mentioned. The vertical milling attachment, built by the same makers, is employed in this case. Most of the work for which the circular attachment is adapted is best done with the vertical attachment. In Fig. 13, however, is shown a case in which the cutter is driven directly by the main spindle, and the attachment is used primarily for indexing. This case is the cutting of a large gear—too large to be swung in any index centers, and so large that even if it could be

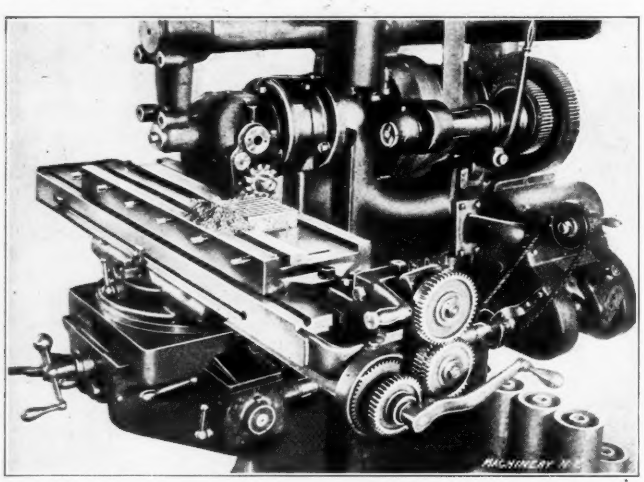


Fig. 16. Change Gear Attachment for Spacing in Rack Cutting and Similar Operations.

swung, the cutting point would be so far above the bearing surface of the table that heavy cuts could not be taken. Arranged as shown, the pressure of the cut is vertically downward, and it may be supported, if required, by a rim rest clamped to the platen. The large diameter of worm-wheel provided is especially suited for indexing work of this character. The wheel is centered by a plug or arbor driven in the taper hole bored in the center of the table.

Slotting Attachment.

The exterior of a slotting attachment for the milling machine is shown in Fig. 14, and its details are indicated in the line drawing Fig. 15. The special features of this attachment are that it can be swiveled through an angle of 360 degrees, that it is supported by the outboard bearing, and that the stroke is adjustable. It thus has a stiffness and a range of action which should make it a very useful device for such work as die making, light manufacturing, etc.

A flanged cap A is bolted to the face of the column. This cap has a bearing for crank-shaft B, whose inner end is provided with a tongue fitting the groove in the face of the nose of the spindle. The face of the crank disk is slotted for the head of bolt C, and has a ring D shrunk on it to prevent the bolt from escaping. Fitted over C is the bushing E, which serves as a crank-pin. The flange of this bushing where it rests on the face of the crank disk is serrated, to match corresponding serrations on the disk. By this means the crank may be adjusted for different lengths of stroke, with the assurance that the adjustment will not slip under any conditions of service. The tool slide F is gibbed in a swivel guide G, which may be adjusted to any angle about axis x-x, and clamped in the required position by bolts H entering the T-slot in base A. The tool slide is operated from the crank by connecting-rod J. The construction of the tool slide and the way in which it is gibbed to G will be best understood from the upper sectional view of the figure. A saddle K is bolted to the face of G, and is provided with a pivot which enters the hole of the overhanging arm, thus supporting the whole arrangement very firmly. The tool itself is held in bushing L, whose flange is graduated in degrees, so that the cutting edge may be revolved and presented to the work at any angle required. The bushing is clamped by bolt M, which locks it on the split hub principle. The gib between

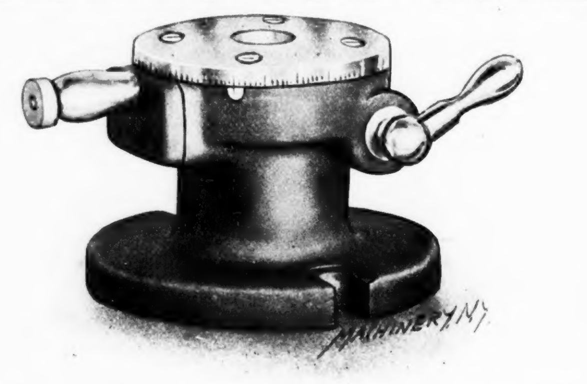


Fig. 17. Vertical Index Head for Slotting Screws, Finishing the Heads of Bolts, and for Similar Work.

G and F, it will be noticed, is provided with a tongue fitting a groove in G to keep it in position. It is tapered and so is adjustable for wear.

Rack Spacing Attachment.

For rack cutting either the universal milling attachment or the spiral gear cutting attachment (both previously described), or the regular rack cutting attachment built by this firm, shown in Fig. 16, may be used. The work, if short, may be held in a regular milling machine vise, or if longer, in a special rack cutting vise such as shown. For indexing the table longitudinally, a new attachment is provided. This attachment, which involves the use of change gears, obviates the necessity for reading graduations on the collar for spacing the teeth. The device consists of a bracket bolted to the table and carrying a quadrant, on which the necessary change gears may be mounted to connect the feed screw and the locking disk. This locking disk is made in two sections and is reversible, one side containing two notches and the other one, for spacing whole or half revolutions. Fifteen change gears are furnished for spacing, giving all diametral pitches from 3 to 6 by half pitches, from 6 to 16 by whole pitches, and from 16 to 32 by even pitches. Circular pitches from 1/16 inch to 1/2 inch by 1/32 inch, and from 1/2 inch to 1 inch by 1/16 inch, are available.

In Fig. 16 will be seen the supplementary connection mentioned as being used for driving a telescopic shaft for the circular attachment, independent of the regular table, saddle and knee feeds. As stated, it consists of a pair of sprocket wheels and a chain, of which the driven member is supported by a special bracket, and drives the outer end of the telescopic shaft.

Vertical Index Head.

The half-tone, Fig. 17, and the line engraving, Fig. 18, illustrate a vertical index head which will be found convenient for such work as cutting clutches, milling the heads of screws, and taking other cuts of a similar nature. The spindle *A* is of steel, and has a tapered bearing in the base *B*, in which it is held by the nut *C*. The latter is split and provided with a lock screw to maintain the adjustment. The upper end of the spindle is provided with a large flange which covers the end bearing at the top of the base, and protects the index ring *D* from chips, oil, etc. This index ring is fastened to the flange of the spindle by screws and dowels, and is locked by bolt *E*. Handle *F* operates a clamp bushing, made on the plan commonly used for holding tools in place in the screw machine turret. In indexing the work, handle *F* is unlocked to release the spindle, lock bolt *E* is pulled out, and the spindle, by grasping the flange or the work, is revolved to the next indexing point, where the lock bolt is allowed to drop in place again. The spindle is again clamped by handle *F* and a new cut is taken. Twenty-four notches are

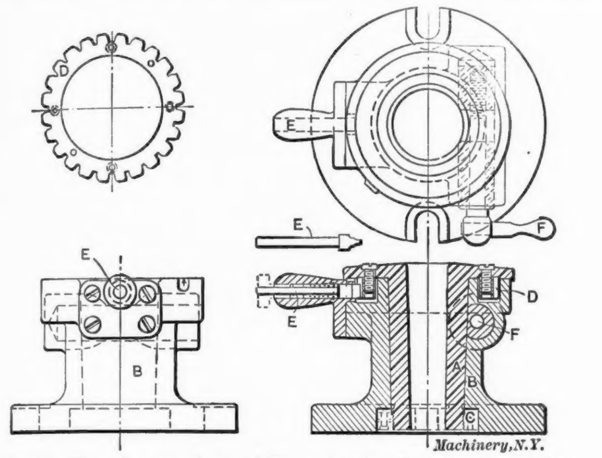


Fig. 18. Elevation, Section and Plan, showing Construction of the Vertical Indexing Head.

provided in the index ring, so that 2, 3, 4, 6, 8, 12, and 24 divisions may be obtained. The spindle has a No. 11 Brown & Sharpe taper hole, in which may be driven the shanks of chucks, threaded arbors, studs, etc., for holding the work. The whole attachment is very rigid and capable of performing severe service.

KEY-SEATING ATTACHMENT FOR SHAPERS AND PLANERS.

In Fig. 1 is shown a key-seating attachment built by the Cincinnati Shaper Co., Cincinnati, Ohio, attached to a shaper of the same make. The attachment consists of a knee with floating jaws for holding the work, and a cutter bar provided with means for feeding and relieving the cutting blade, and for attachment to the tool-post of the shaper. Special attention has been given to the matter of quick acting and secure means for holding the work, and convenient and strong mechanism for controlling the adjustment and relief of the blade. Owing to the rapidity of manipulation possible and to the fact that the cut is taken on the drawing stroke, the output of the device is very high.

Description of the Attachment.

The holding arrangement for the work, as is best seen in the line drawings, Figs. 2 and 3, consists of a knee *A*, provided with ways, in which jaws *B* and *B* are drawn together by the right- and left-hand screw *C*. A bushing, *D*, is provided, having a flange seated in a counterbored recess in the knee *A*, and having an outside diameter closely fitting the bore of the work in which it is desired to cut the keyway. In clamping the work in place, it is simply slipped onto *D* and screw *C* is tightened to bring the jaws *B* up against the work, which may be either rough or finished, without altering the conditions under which the work is held, since it will be seen that the gripping points are of the "floating" variety, adapting themselves to any surface or dimension presented. When so held, the work is located on the bushing *D*, by the bore, so that the key-seating is assuredly true with the hole.

The cutter bar *E* passes through an eccentric hole cut in bushing *D*. It is clamped to the head of the ram through a universal joint at *F*, the connection being made by a screw *G*.

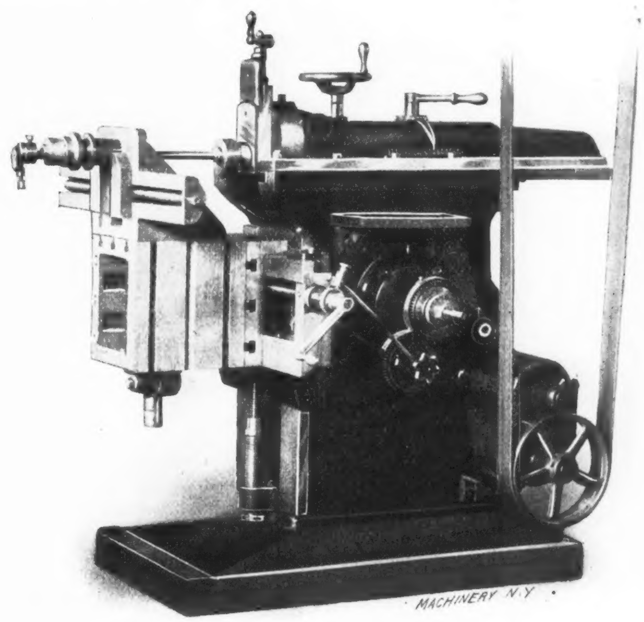


Fig. 1. Key-seating Attachment applied to Cincinnati Shaper.

Provision is made in this universal joint to prevent the cutter bar from rotating. The cutter *H* is made from a simple block of tool steel, with a cutting edge formed to give clearance and top rake. It fits loosely in a slot cut through the bar as shown. A groove is cut across the rear edge, engaging the eccentric pin formed on the end of feed rod *J*. (The small details shown will assist in getting an understanding of these various parts.) By means of feed rod *J* the cutter is fed downward and relieved on the back stroke, since any rocking movement imparted to it effects a vertical movement of *H*. A slot, of course, is cut in the bottom of bushing *D*, as shown in the detailed section, to permit the cutter to project through into the work. A corresponding slot is formed in the cutter bar itself to give clearance room for chips.

Feed rod *J* extends to the front end of the cutter bar, where it is keyed to lever *K*, by means of which the operator controls the cross movement of the cutter. A screw *L*, entering a recess in *J*, prevents it from being shifted longitudinally. An eccentric *M* is keyed to an extended hub on bar *E*, and projects over a hub of corresponding diameter on lever *K*. Screw *N* has a projecting pin which enters a groove cut in the periphery of the hub *K*, thus tying it to eccentric *M*, while still permitting it to revolve. *M* and *K* may thus be pulled off of *E* and *J* respectively, to which they are keyed, and

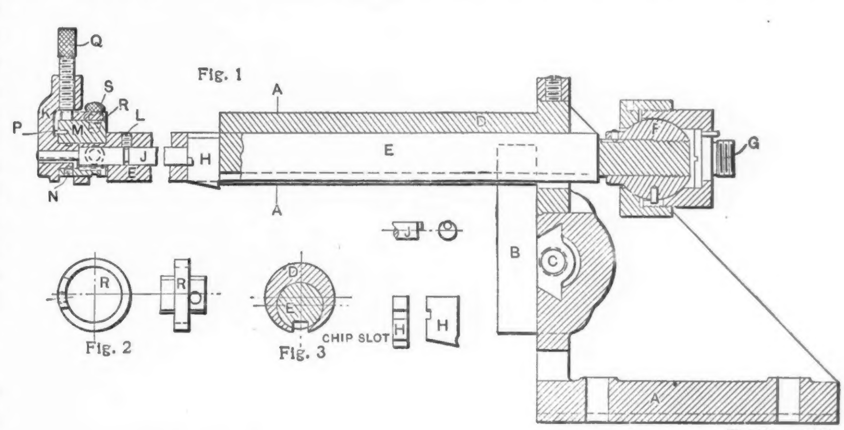


Fig. 2. Section through Cutter-bar of Key-seating Attachment.

replaced if desired, being handled as a single unit. *M* is fastened to *E* by a set-screw *O*, when the device is in operation.

The movement of *K* may extend through an arc of 180 degrees. In the upright vertical position shown, cutter *H* is extruded to the limit of its movement. If *K*, in Fig. 3, were swung vertically downward toward the right, *H* would be withdrawn to the limit of its upper movement. The swinging of *K* in a downward direction is limited by the striking of a projection on its hub against stop pin *P*, driven in eccentric *M*. The upward movement is limited either by the striking of the point of adjusting screw *Q* against the periphery of eccentric *M*, or against the projection on adjustable stop collar *R*, which may be clamped in any desired position on *M* by thumb-screw *S*.

Method of Operating.

Having thus described the mechanism, we are able to follow the method of operating the device. First, lever *K* is turned around 180 degrees from the position shown, to its lower vertical position, thus entirely withdrawing cutter *H* within the bar. Thumb-screw *O* is then loosened, and eccentric *M* is withdrawn, taking arm *K* and the attached parts with it. The work is then slipped over bar *E* and onto bushing *D*, which fits its bore. Floating jaws *B* are then clamped on the work, holding it securely. Eccentric *M* and lever *K* are next replaced in position and clamped there by screw *O*, lever *K* remaining in its downward position. Adjusting screw *Q* is now set so that it nearly touches the eccentric in this position, and the shaper is started up, it being understood that the stroke is set properly for the work in hand.

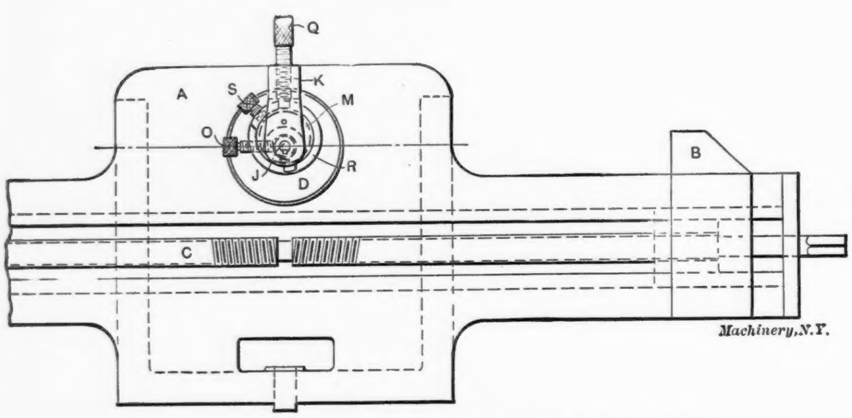


Fig. 3. Face View of Attachment showing Vise Jaws for Holding Work.

As the ram commences its cutting stroke, which is the inward stroke in this case, the operator throws the lever *K* around in the direction opposite to the hands of a watch, until the point of screw *Q* stops against the eccentric surface of *M*. This, as explained, throws blade *H* downward, probably far enough to take its first chip. When the blade has passed through the work, the operator, with his hand constantly on *K*, again swings it back against stop pin *P*, meanwhile unscrewing *Q* a trifle more. At the beginning of the next cutting stroke he again swings it around in a counter-clockwise direction until the point of *Q* again stops against the eccentric surface of *M*, this time further around, causing *H* to project out a little further and take a second chip. This operation of feeding in deeper on the cutting stroke and relieving on the return stroke, is continued until the key-way has been cut in the work to the proper depth. This depth is located by stop collar *R*, which is adjusted on *M* to limit the movement of *K* to the position that gives the proper depth of keyway. *R* is clamped in its position by thumb-screw *S*. The work being then completed, arm *K* is returned to its lower position so that the cutter blade is withdrawn; then *K* and *M* are removed (thumb-screw *O* is loosened) and the finished work is slipped off of bushing *D* and a new piece placed in position, after which *K* and *M* are again replaced and the operation proceeds as before.

As evidence of the ability of the device to handle repetition work in large quantities, it may be mentioned that 400 pieces similar to the one shown in the machine in Fig. 1, were key-seated at the rate of 2½ minutes apiece. The key-way was ¼ inch wide, ⅛ inch deep and 7 inches long. The material was high grade steel casting.

Practice in Finishing Gear Blanks in the Shops of the Builders.

One feature of the shop practice of the Cincinnati Shaper Co., is dependent on the use of this attachment. Owing to the fact that the key-way is cut true with the bore, no matter what the condition of the outside surface by which it is gripped, this operation may be performed immediately after the chucking. As is common practice in making gears of the first quality, gear blanks in this shop are finished on a true lathe arbor. The key-way being cut before turning, an opportunity is afforded for putting a key in the arbor for driving the gears. A gear thus mounted on the arbor is shown in Fig. 4, together with the arrangement of the tools in the special slide rest which is used for facing the blanks. Since it is not necessary to depend on the forced pressing of the arbor into the work for driving the latter, it is possible to press a snugly fitting arbor of the kind shown, into the key-seated bore of the blank to the same point every time in such position that the edges of the finished faces will overhang slight clearance spaces on the arbor. When so arranged, the double roughing tool may be fed down until it rough faces the two sides of the gear down almost to the arbor. Returning the cross-slide, the two facing tools at the rear may be brought up, finishing the sides completely, clear down to the bore, and running out into the slight clearance spaces mentioned.

The fact of the blank being keyed prevents the longitudinal shifting of it on the arbor which might take place if the latter

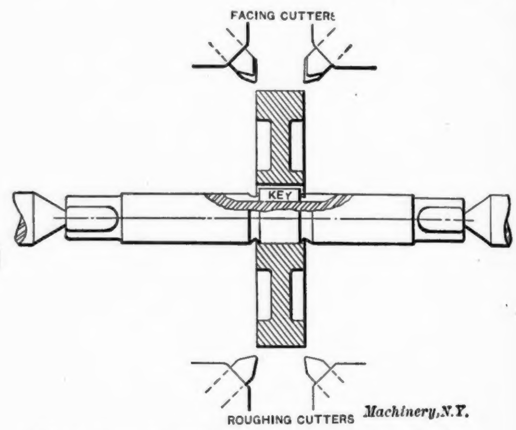


Fig. 4. Facing Gear Blanks, mounted in the Lathe on a Keyed Arbor.

were pressed into the work no more firmly than would be the case here, with holes varying slightly in diameter. In order to slip easily on an arbor lengthwise, the work must rotate on it as well, and this rotation is prevented by the key. The finish turning of the blanks is done on true gang arbors, on which the work is stacked to the full capacity of the arbor. Owing to the fact that two sides of the gears are faced in the same operation, they are true with each other and with the bore, so the gang arbor is in no danger of being sprung when the work is tightened up on it. This makes a very rapid and very accurate method of finishing small gear blanks that are made in large quantities.

Range of Sizes.

The bars *E* are made in seven sizes, to cut all key-seats up to 1-inch in width, in holes from 9/16 inch upwards, in diameter. Bushings *D* are furnished in any desired size to fit the bore of the work to be key-seated. Bushings for cutting tapered key-ways will be furnished if desired. The device is evidently applicable to the planer, as well as to the shaper.

GEARED FEED DEVICE FOR THE CINCINNATI LATHE.

A positive-geared feed device, giving six changes, has recently been applied to the Cincinnati 16-inch engine lathe, by its builders, The Cincinnati Lathe & Tool Co., Cincinnati, Ohio. This feed box, as may be seen from an inspection of the half-tone engraving in Fig. 1 (where it is shown attached to the lathe) and of the line engraving, Fig. 2, is of original

and interesting construction, and seems to have been so designed as to accomplish its work with very few parts and simple mechanism.

Referring to the line engraving for the details, *A* is the lathe spindle which, through the usual reversing tumblers *B*, drives the stud gear shaft *C*. From this, connection for threading may be made with the lead-screw *D* by the usual

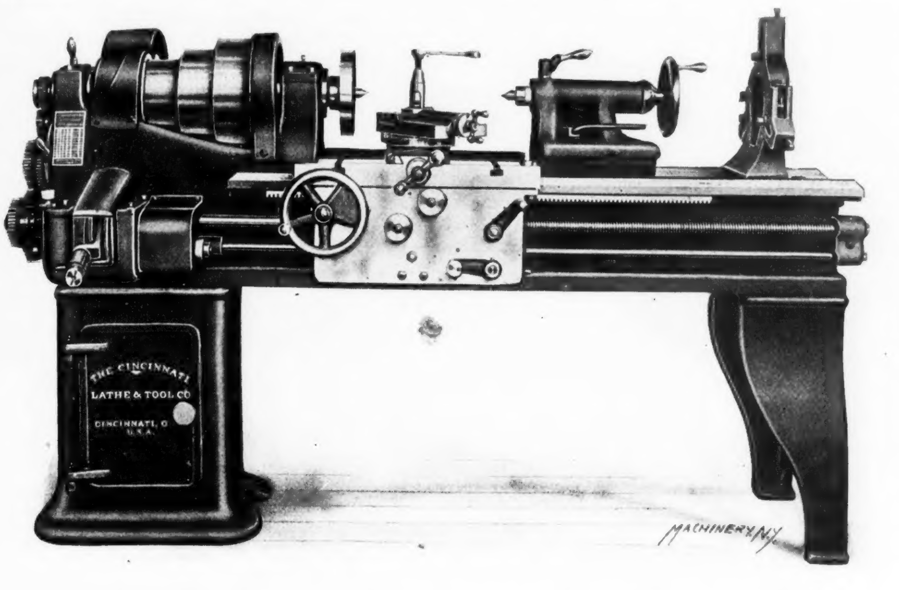


Fig. 1. Cincinnati Lathe provided with Improved Quick Feed Change Device.

change gears. Mounted on the change gear stud on the inside of the head-stock, is bevel gear *E*, meshing with a pinion *F* driving a worm-shaft *G* which is supported by bearings in swinging arm *H* pivoted about shaft *C*. To shaft *J* in the feed box is splined a triple worm-wheel *K*. Any one of the three wheels composing this may be shifted into position under worm *L* by means of a slide *M* on the outside of the

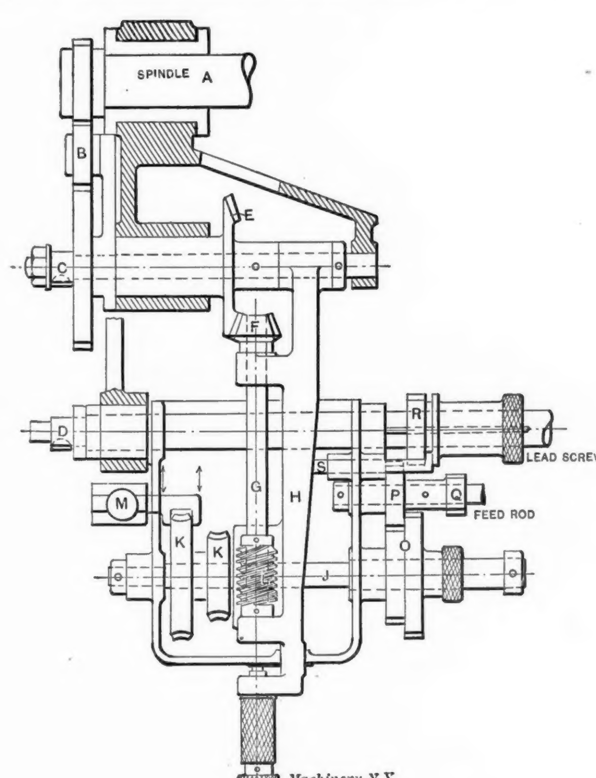


Fig. 2. **Arrangement of Feed and Screw Cutting Connections for the Cincinnati Lathe.**

box. The inner extension of this slide embraces the largest of the wheels and so controls the axial position of all three. Arm *H* extends out through the feed box at the front of the lathe, where it is provided with a lock bolt *N*, by means of which it may be fixed at any one of four different vertical positions. To change the rate of feed, *N* is pulled out and arm *H* raised until the worm *L* is out of reach of the worm-wheels *K*. Then fork *M* is shifted to bring that one of the three worm-wheels corresponding with the desired feed into position beneath the worm. Arm *H* is then dropped to the corresponding vertical location for that wheel and locked in place by bolt *N*. The three changes thus obtained are doubled by means of the double sliding gears *O* which may be shifted to engage with either *P* or *Q* on the feed rod, thus giving six changes in all, varying from 16 to 100 turns per inch. This is sufficient for general manufacturing work.

In addition to these speeds which are instantly obtainable, 22 additional changes ranging from 5 to 64 per inch, may be obtained, to suit special cases, by using the regular change gearing between *C* and *D*, and shifting sliding gear *R* on the lead-screw into engagement with gear *P* on the feed rod, which is thus driven from the spindle. To make it possible to drive the feed rod in this way, without interfering with the regular drive through the worm gearing, a lock bolt *S* is provided, having a finger engaging a groove in slip gear *R* and projecting into the feed box in the path of the swinging movement of arm *H*. Bolt *S* and arm *H* are so placed that the former prevents gear *R* from being thrown into mesh with *P* until *H* is raised to its extreme upper position, where engagement with even the largest of the worm-wheels *K* is impossible.

This lathe has been previously built in two forms, either with the Emmes patent quick change gear device, or with plain belt feed. The lathe with the feeding device we have just illustrated is intended to take the place of the belt feed machine, and will be furnished at the same price. The range of feeds provided appears to be suitable for ordinary work without requiring the use of the change gears at all for feeding. It will be noted that the feed is independent of the screw-cutting motion, so that the lead-screw is not operated except when required for actual threading. The machine shown in the illustration has a 3-step cone and double back gears. If required by the purchaser, a 5-step cone and single back gears will be furnished instead.

EBERHARDT BROS. UNIVERSAL AUTOMATIC GEAR-CUTTING MACHINE.

The Eberhardt Bros. Machine Co., 66 Union St., Newark, N. J., has recently built the remarkable gear-cutting machine illustrated herewith. In Fig. 1, a blank is shown, cut with the various styles of teeth which the machine is capable of producing. As may thus be seen, it is practically universal in its adaptability, it being designed for the cutting of spur, bevel, skew, and face gears, besides being useful for gashing worm-wheels. It is intended to fill the requirements of a machine for stocking out bevel gears preparatory to finishing on a planing machine, and, likewise, of jobbing and repair shops for finishing bevel gears by the formed cutter method. This is done without limiting the capacity of the machine for spur gear work, in the way met with in the ordinary automatic spur and bevel gear cutter, provided with a swivel adjustment for the cutter slide. In other words, this machine will finish spur or bevel gears with equal accuracy, and with an equal output.

Structural Features of the Machine.

A heavy base casting is provided, having at one end guides on which the work spindle head is adjustable longitudinally, and on the other, a seat of circular form, on which the cutter head stanchion may be adjusted to the proper angle for any gear from a spur to a face gear. The work head, it will be

seen, is adjustable in two directions. The adjustment of the saddle on the bed is for accommodating different diameters of blanks, and for setting the cutter to the required depth. That of the spindle head on the saddle is at right angles to the first, and is used to accommodate bevel gears and pinions having varying lengths of hub, so as to bring the point of the pitch cone to the proper position. This also is used to

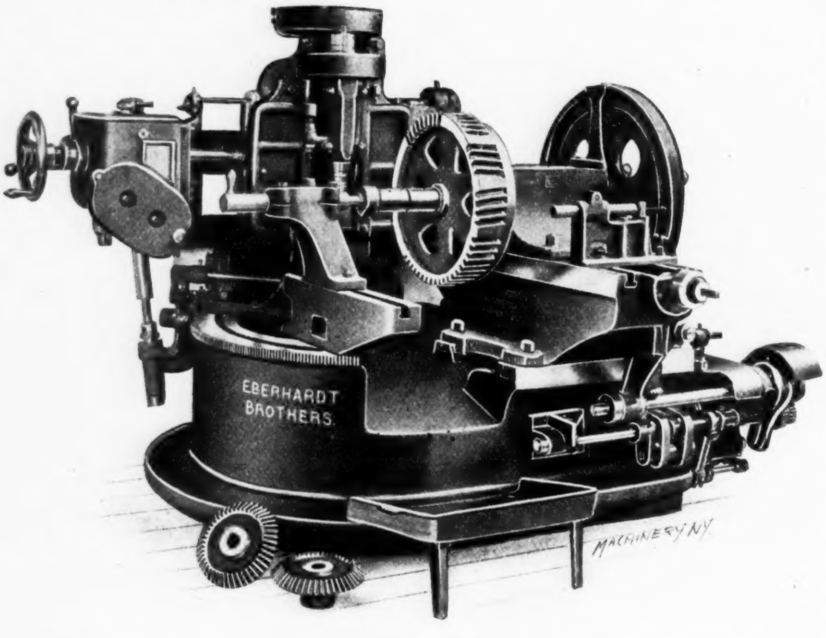


Fig. 1. An Automatic Machine for Cutting Spur and Bevel Gears; also adapted for Worm, Skew, and Face Gears.

set the cutter to depth in cutting face gears. The screws for both of these movements are provided with adjustable dials, graduated to read to thousandths of an inch. The screw which makes the adjustment for the diameter of the blank may be operated from either end, as most convenient.

The method by which the cutter slide is supported and the cutter driven, may be understood by reference to the line drawing, Fig. 3, in connection with the two half-tones. The cutter stanchion *A*, as has been explained, is adjustable about its circular seat on the top of the base to the required angle. The axis of adjustment is shown at *x-x*. The cutter slide itself, *B*, is mounted on a guide *C*, which swivels through a limited angle on a bearing on the face of stanchion *A*, about axis *y-y*. The slide *C* is set by this adjustment to the required angle for making the approximation necessary when cutting bevel gears by the formed cutter process, and is clamped by bolts *D*. For spur gears, of course, the slide is set in a horizontal position, shown in Fig. 3. For cutting skew gears (much used in steel mill work in place of the more expensive and less easily removed worm-wheel) slide *C* is set to agree with the helix angle of the worm the skew gear is to mesh with. In gashing worm-wheels the same thing is done. For this latter case, of course, the automatic feed is not used, the work slide being fed on the saddle to the proper depth by hand for each cut. It will thus be seen that the cutter slide and work are as strongly supported when the work is set for cutting bevel gears, or even for face gears, as when cutting spur gears.

The Driving Mechanism.

The machine is driven through constant speed pulley *E*, which is connected by bevel gearing with a shaft *F*, whose center line is on axis *x-x*, about which *A* is adjusted. Shaft *F* is connected in turn by bevel gearing with shaft *G*, journaled in cutter head *A*. *G* is connected by spur gearing with shaft *H*, with center line on axis *y-y*, about which *C* is adjusted. This, in turn, is connected by spur gearing with shaft *J*, connected at one end with the feed box *K* for the power feed and quick return, and at the other by spur gearing to splined shaft *L*, which drives bevel pinion *M*, supported in a bracket attached to cutter slide *B*. *M* meshes with bevel gear *N*, which is keyed to a vertical shaft which is connected with shaft *O* by change gears as shown, for obtaining the required rate of spindle speed for the case in hand. A pinion on *O* drives the spindle gear *P*. The same provision for adjusting the spindle *Q* lengthwise is made in this machine as with the usual automatic gear-cutting machine. It will be seen from the foregoing that the spindle drive is effected from a pulley of fixed position, without interfering with the two angular adjustments of the cutter slide, or the axial adjustment of the cutter spindle. For making the angular adjustments of the cutter stanchion, a worm is provided, engaging a circular rack secured to the bed. The worm carries a dial graduated to read to minutes of a degree, one degree being a whole turn of the crank.

Feeding and Indexing.

The feed of the cutter carriage is varied by change gears, the quick return remaining constant. The cutter speeds and feeds are entirely independent of each other. The thrust bearings for the feed-screw are placed at each end, so that the screw is not under compression either during the feed or the return of the carriage. This "draw-cut" principle is said to reduce vibration and chattering to a marked degree. The cutter carriage is of exceptional length, and travels on long and narrow guiding surfaces of the same construction as on the spur gear machines built by the same firm. The cutter spindle is in the center of the length of the carriage, thus preventing the possibility of lifting the latter, or "gouging" on the part of the cutter, when beginning the cut.

The indexing mechanism is positive, and is operated by means of a rod from the feed box trip mechanism, as is usual on spur gear cutting machines. As this rod operates through the centers of angular adjustment of the machine, no attention is needed whatever when the stanchion or swivel slides are moved for different angles, or when the head is moved in either direction. The use of chains is eliminated; there are only the two usual dogs to be set to suit the various lengths of face of the gear blanks. The indexing worm runs in a bath of oil and meshes with an index wheel of large diameter, made in halves to insure accuracy.

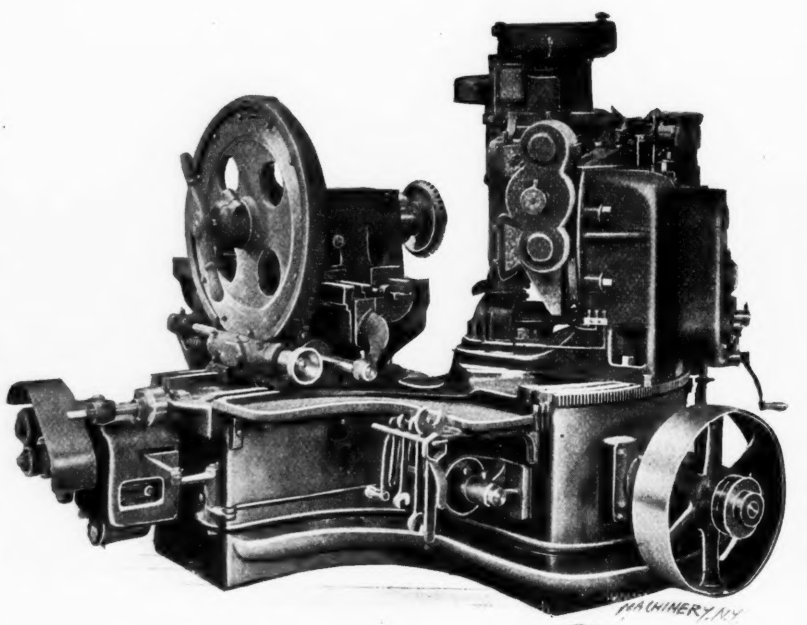


Fig. 2. Rear View of the Universal Automatic Gear-cutting Machine.

Incidental Features of the Design.

An outside support is furnished for the work arbor, as shown in Fig. 1. This support accommodates wheels up to the full diameter of the machine, and is easily removed. Rim rests are provided to support large gears against the thrust of the cutter. A face-plate is also provided, with chucks and drivers for positively holding and driving wheels of large diameter. The cutter and work spindles have tapered holes, and each is provided with a draw bolt for positively drawing in and forcing out arbors. The work spindle is a machine steel forging, while the cutter spindle and arbor are of tool steel. All driving shafts are of high carbon machinery steel and finished by grinding as, of course, are also the spindles.

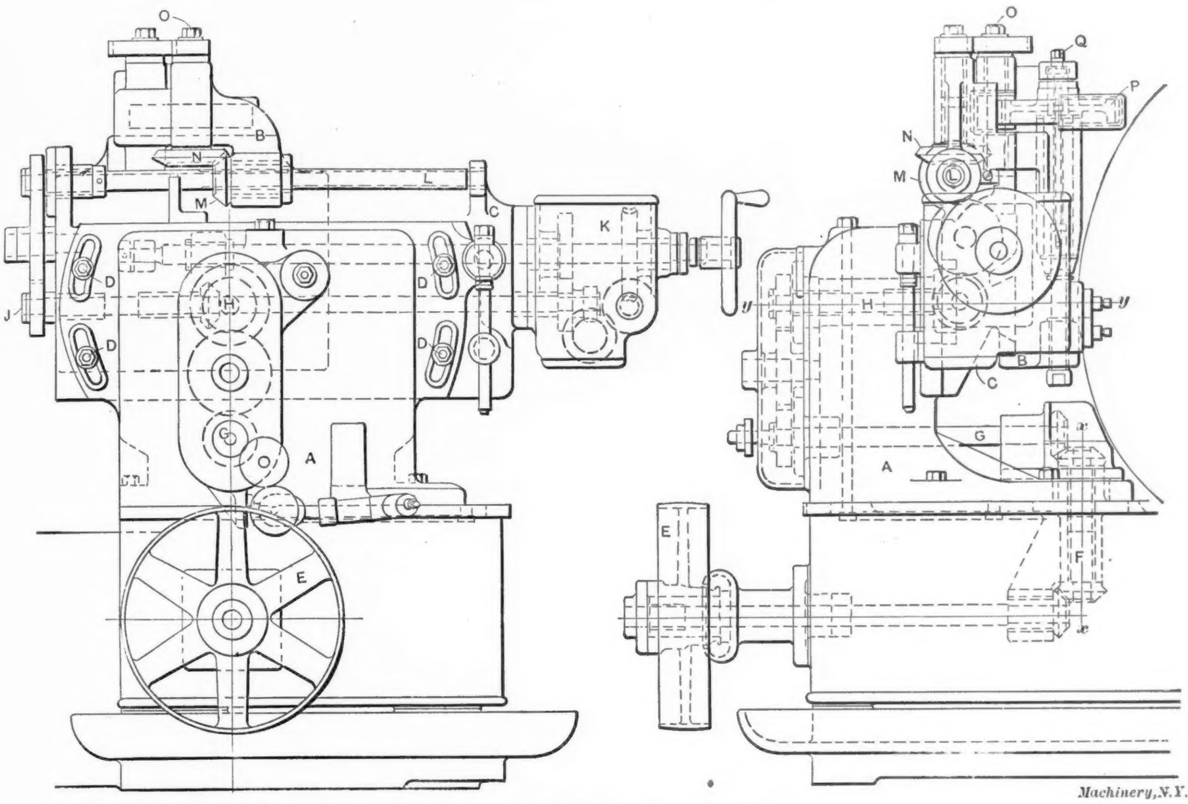


Fig. 3. Front and Side Elevation of Cutter End of Machine, showing Cutter Slide Adjustments and Method of Driving.

Fig. 1 shows very plainly the convenient height of the machine, and the accessibility of all the parts, such as the hand indexing and feed levers at the left of the machine, near the feed hand-wheel. These are used when setting the machine and are always within easy reach, being about 4 feet from the floor. A number of minor conveniences will be noticed. The change gears are enclosed by hinged covers, and guards are provided for encasing all the gearing. The oiling facilities provided have been carefully studied out. The bearings of all shafts and spindles operating in a vertical position have spiral oil grooves, cut in the opposite direction to the rotation of the shaft, so as to retard the downward flow of the lubricant. Felt wipers are arranged on all the planed bearing surfaces to keep the dirt and chips out, and retain the oil. An oil pump with suitable piping and reservoir is provided for supplying a lubricant, as when cutting steel.

Capacity.

The machine has a capacity up to 48 inches in diameter, and 10 inches face, and will cut 3 diametral pitch in steel and 2½ diametral pitch in cast iron. By taking stocking cuts, heavier pitches can, of course, be cut. One of the first lot of these machines built is cutting 2 diametral pitch in steel as its regular work. It will be noticed that, owing to the construction of this machine, the full capacity, so far as diameter is concerned, is available whatever the angle at which the cutting takes place. This is owing to the fact that the swivel is effected by the cutter slide instead of by the work spindle, so that the latter always bears a definite relation with the clearance cut in the base for swinging work of large diameter.

PRESSED STEEL TROUGHING AND RETURN ROLLS FOR CONVEYOR BELTS.

The question of troughing conveyor belts has always led to controversy, and about the only point that seems to have been definitely settled, is that with deep troughing-rolls the belt must be made so that it will bend to the required shape; and to obtain this shape with the ordinary multiple pulley idler, the belt is sometimes made up with fewer plies of fabric at the flexing part. The rubber protective cover of the belt has little or no tensile strength, and the result of weakening the fabric, especially in cases of the wide belts designed for large carrying capacities, is to bring about a weakening at the very point where the load is heaviest and the bending of the belt most severe.

An improved type, of pressed steel, is shown in the illustration. The carrying-roll, firmly secured to the through shaft which revolves in self-oiling, dust-tight bearings, consists of

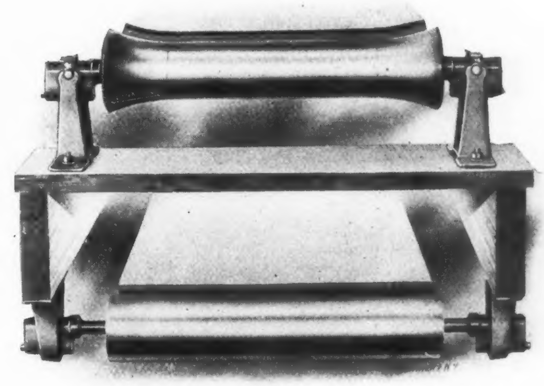


Fig. 1. A Pressed Steel Troughing Roll which gives a Maximum of Life and Carrying Capacity to the Conveyor Belt.

three parts rigidly fastened together—one straight middle section, and two bell-shaped end-sections, the inner edges of which are flanged so that the center section overlaps each snugly, making a close joint and a well balanced roll. The ends are closed, which prevents entrance of material to interfere with the rotation of the roll or throw it out of balance. A point is also made of the clear height above the supporting

plank, as this effectually removes the roll from possible contact with spilled material. The carrying-run is thus over a one-piece roll on which the loaded belt bears evenly for its entire width. The result is that all troughing strain is eliminated and the belt wear is confined to ordinary carrying service; nor does observation show that the difference in diameters of the roll injures the under side of the belt. This is no doubt due to the fact that the roll revolves at the speed of the loaded part of the belt and that rubbing is confined to its edges. The wear here is slight, and it has been found that the life of the belt is determined by the wear on the carrying part rather than on the under side.

The return rolls are of the one-piece, straight-face type, set-screwed to a through shaft which revolves in bearings identical with those on the carrying-run. Both rolls are compact, light and strong, and in service, under severe conditions, show remarkable durability. The lightness and simplicity of construction have so reduced the initial cost that closer spacing is possible, and this, where high speeds and great capacities are desired, prevents sagging of the belt and assures smooth, easy operation, lessened horse-power consumption, and a minimum of belt wear. As the rolls are fixed to the shafts which, as noted, revolve in oil, the lubricating points for each are reduced to two, and these are so accessible that the bearings are always in good condition.

The following considerations should govern the adoption and use of the belt conveyor principle. First, it should be used only for materials to which it is adapted, there being no such thing as a universal conveyor. Second, the more nearly a belt conveyor approaches the flat position, the longer the belt will last, so troughing should be shallow enough to allow the belt to assume its shape naturally and without strain. Third, the belt, however it is made, should be uniformly strong throughout its width, its construction being governed entirely by the material to be handled and the conditions under which the conveyor must be run. The roll just described, when used as it should be, conforms to the above conditions. It is built by the Link-Belt Co., Philadelphia, Pa.

THE DILL DRIVE.

The T. C. Dill Machine Co., Philadelphia, Pa., is building the variable speed drive shown in the accompanying illustrations. As may be seen at the first glance, it embodies an exceedingly ingenious principle of action and is constructed along novel lines, though it somewhat follows the principle of the well-known Sellers drive in the matter of varying the speed by forcing straight disks in between tapered disks, pressed together by springs, the drive being by the frictional contact between the edge of each straight disk and the sides of its mates on the other shaft. By varying the center distances of the two sets of disks, the diameter of the drive on the tapered disks is varied, thus altering the speed. The novelty of the construction consists in multiplying these disks to as great an extent as required to transmit the desired power, and in making them of thin steel stampings, allowing the whole arrangement to be of very compact construction. Refinements have also been introduced in the methods of applying the pressure, and in varying the center distances of the disks.

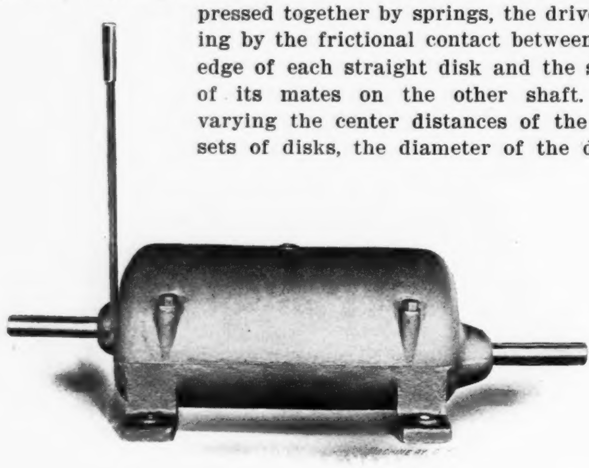


Fig. 1. Dill Variable Speed Drive as supplied for General Use.

The Commercial Form of the Device.

A variable speed device of this type is shown in its enclosed form in Fig. 1, and with the cover removed in Figs. 2 and 3. The shaft which extends from the casing at the opposite end from the handle, is the one which receives the power. On a squared portion of this shaft are loosely mounted flat ground disks, punched from steel plate, with the holes to fit the shaft. The driven shaft, which delivers the variable speed from the device, has a similar squared portion on which are loosely mounted similar flat ground disks with squared holes. Between these constant speed and variable speed shafts is mounted a third, whose bearings are supported by arms keyed to a rock shaft, parallel to the other two. On this intermediate shaft are mounted tapered disks which enter the spaces between those on the other two shafts. They are held to this intermediate shaft in the same way as the others, by squared seats. By means of the heavy coiled spring shown, which presses together the flanges which confine them, all the disks in the device are pressed into contact with each other. The rock shaft on which the arms are mounted which support the intermediate shaft, is provided with a handle by means of which the latter may be swung toward either the constant speed or the variable speed shaft. In the first case, the edges of the constant speed disks come in contact with a smaller diameter of the intermediate taper disks, while those of the driven shaft, on the contrary, engage a larger diameter of the disks they engage with. This results in the increase of the speed of the driven shaft. Of course, this shifting of the center distance between the shafts alters the spacing of all the disks, as the straight ones enter or recede from the tapered openings between the tapered disks. Owing to the rapid rate of rotation of the shafts, this side adjustment takes place practically instantaneously, all of the disks being free to move endwise on the squared shafts, as explained, except for the pressure of the coiled spring on the intermediate shaft, which gives the pressure required for the driving.

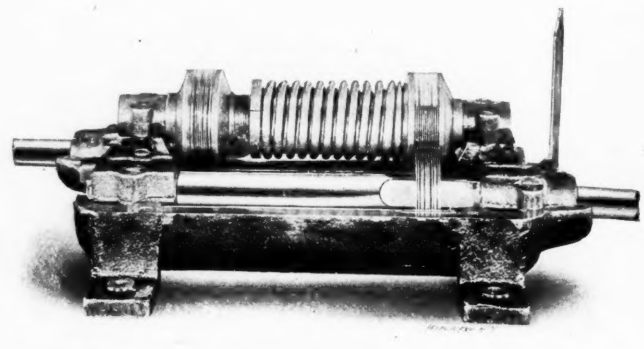


Fig. 2. View of the Dill Drive with Cover removed from Casing, showing the Alternate Sets of Flat and Taper Disks which Transmit the Power.

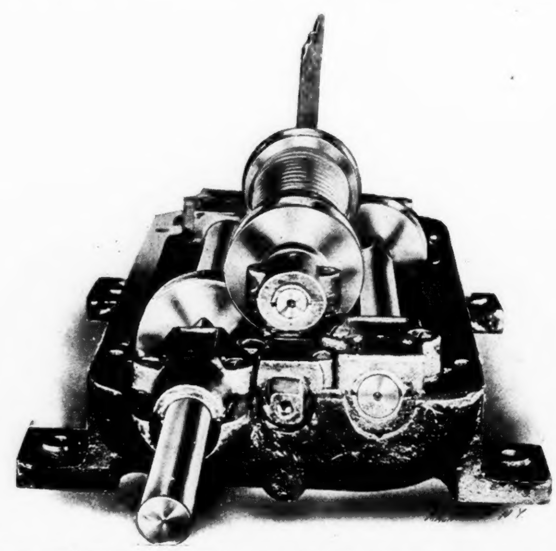


Fig. 3. End View of the Drive, showing the Method of Supporting and Shifting the Intermediate Shaft to change the Speed.

The contact between the flat and tapered disks is but a spot, and as they have a rolling action on each other, the frictional resistance is reduced to a minimum. Great power, while still retaining exceptional endurance, is obtained by first determining the proper pressure from the standpoint of endurance for one disk, and then adding a sufficient number to transmit the power required. The spring is adjusted to suit the load at a given speed, and as the speed is increased the pressure is reduced, and *vice versa*. Owing to the peculiar construction of this spring, constant horse-power output is attained by making the pressure vary with the speed.

The apparatus shown in Figs. 1, 2 and 3 shows the drive in the form in which it is being put on the market as a speed box for general use. These speed boxes are made in several sizes, from ½ horse-power up, and with a speed ratio of 5 to 1, though more or less can be had if desired. The drive shown, which is suitable for 5 horse-power, is 23 inches long and 15 inches wide over all, including the extensions for the feet and bearings. The frame proper is only 19 inches long, 11 inches wide, and 9 inches high. The disks are 4 inches in diameter and 3/64 inch thick. The constant speed shaft runs at 400 revolutions per minute. Compactness will thus be seen to be a prime characteristic of this device, as compared with others previously built for the same purpose.

Direct Application to Lathe Head-stock.

Instead of giving the constant-speed shaft a velocity midway between the highest and lowest of the driven shaft, the diameters of the disks may be so arranged that the change of speed is all in the direction of a reduction, so that the highest speed of the driven shaft does not exceed the initial speed. This arrangement is recommended as being a suitable design for incorporating in the head-stock of a lathe or boring mill. Such a modification of the device is shown in the sketch of Fig. 4 which suggests a suitable arrangement of the Dill drive as applied to a lathe head-stock.

In this sketch it will be noted that the flat disks *N* (which are fitted directly to a squared seat on the spindle *B*) are 14 inches in diameter, meshing with 12-inch tapered disks *K* on the intermediate shaft *C*. On the other end of the intermediate shaft is another series of flat disks *L* 12 inches in diameter, which intermesh with tapered disks *M* of the same size on the constant-speed shaft *A*. Sufficient power for this application to the lathe may be obtained with a comparatively small number of disks. With the arrangement shown a speed ratio of 30 to 1 is obtainable.

It will be noted that in this case, instead of swinging intermediate shaft *C* from *A* toward *B*, it is mounted on arms *E*, pivoted in such a way that it approaches or recedes from *A* and *B* simultaneously. This construction is still more compact than that shown in the variable speed counter-shafts in Figs. 1 to 3. The change in the movement of the intermediate shaft as compared with the first design, necessitates a rearrangement of the disks. As will be noted, the tapered disks are mounted on the driving shaft and the driving end of the intermediate shaft, while the flat disks are mounted on the driven end of the intermediate shaft and on the spindle. This also necessitates two sets of compression springs, *O* and *Q*, for giving the pressure required for transmitting the power desired. The spreading apart of the disks and the consequent increased pressure of the springs as the speed decreases, gives the increased torque required for transmitting constant power at variable speed—a provision which is necessary in the case of lathes.

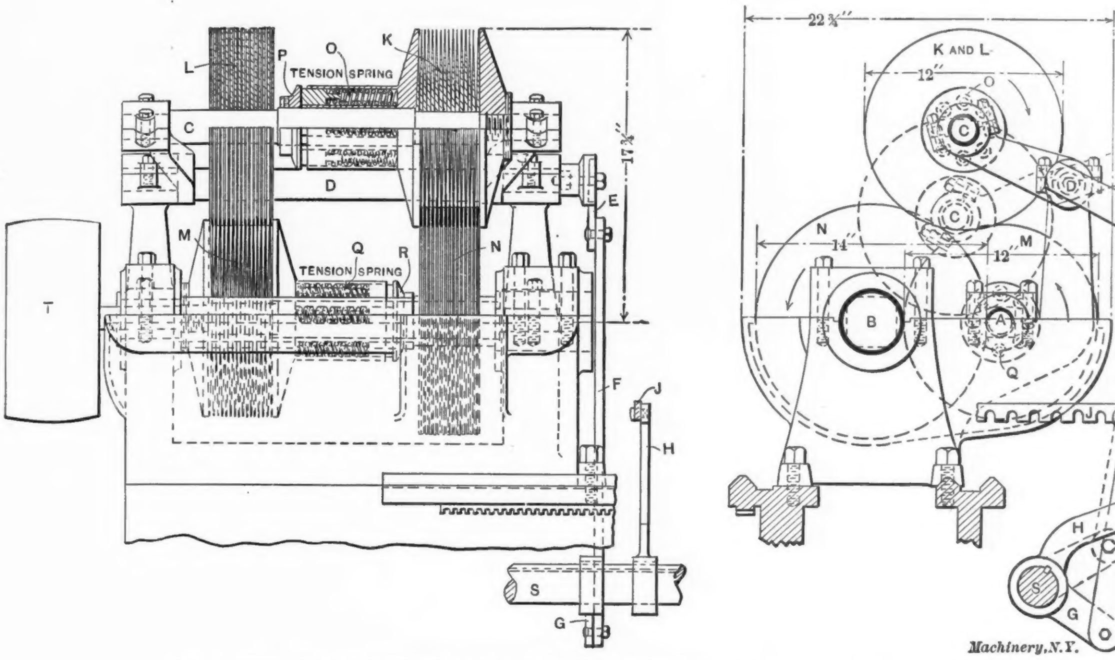


Fig. 4. Suggested Arrangement of Dill Drive as Incorporated in the Head-stock of a 20-inch Lathe.

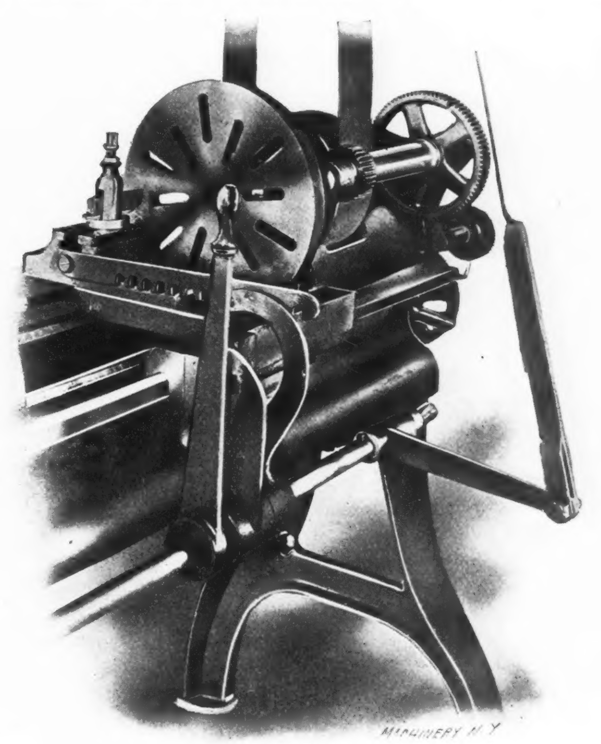


Fig. 5. Arrangement by means of which the Speed of the Drive, mounted on the Counter-shaft, is controlled by the Position of the Tool-post, for Facing, etc.

Automatic Speed Control for Lathes.

The sketch shows an arm *H*, having a pin adapted to engage any one of a number of notches in a link *J* attached to the cross-slide. This arm is connected by link *F* to rock shaft *D*

in such a way as to vary the speed with the position of the cross slide, thus automatically adapting it to the diameter of the cut. This would be very convenient for facing cuts, or for work in which the diameter is constantly varying. The lathe shown in Fig. 5 is provided with a somewhat similar arrangement, intended, however, to be used with a variable speed box such as shown in Fig. 1, bolted to the ceiling. In this case the bell-crank at the rear is connected by a long link with the rock shaft of the speed box on the ceiling. A lever is also provided, as will be shown, by which the speed is changed manually when desired, the lever being so arranged as to slide with the carriage and be always in convenient position for the operator. The lathe in this case is adapted to the variable speed box drive by slipping a special wide-faced pulley over the two largest steps of the cone, thus giving a more powerful drive than the original construction, as well as a more flexible one.

THE NORTON 20 x 192-INCH GRINDING MACHINE.

The machine shown in the two accompanying engravings, is the latest addition to the line of grinding machines built by the Norton Grinding Co. of Worcester, Mass. The machines shown are notable for their great capacity, particularly in regard to length. They are especially intended for grinding long and heavy shafts such as found in stationary engine and marine work, as well as for finishing shorter work, such as spindles, etc. The machine shown is not by any means the longest of this size the builders are prepared to make, though it is the limit practicable with the bed cast in one piece. In the case shown, the base is 30 feet long; for greater lengths it is made in three pieces. That for the largest machine of the series (which is capable of grinding work 22 feet between centers) has a base 42 feet long.

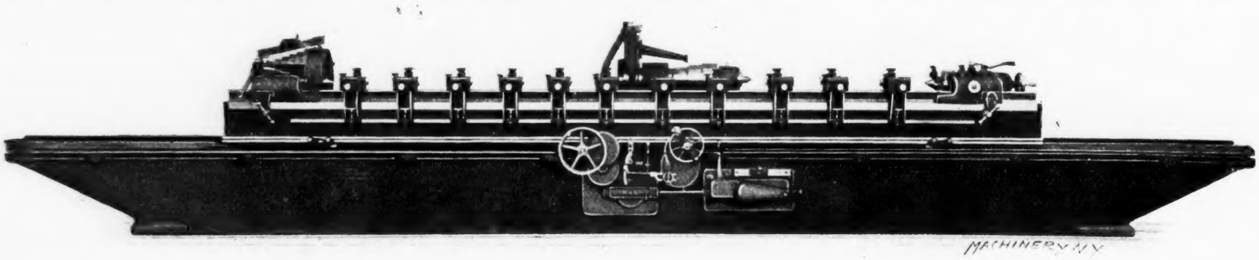


Fig. 1. A Norton Grinder of Unusual Capacity, designed for the Finishing of Heavy Engine and Marine Shafts.

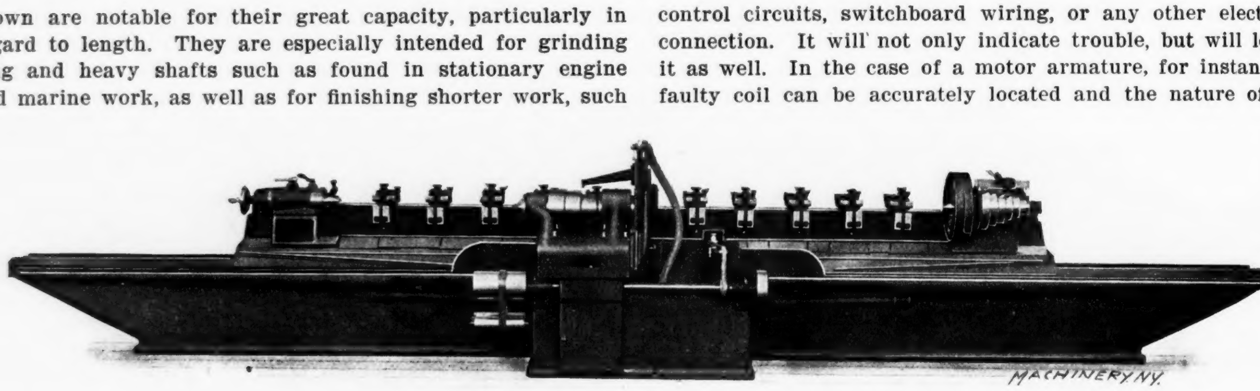


Fig. 2. Rear View of Heavy Norton Grinder. The Bed is made in Lengths of from 8 to 22 feet.

The base casting is unusually heavy, even when its size is considered. The ways are provided with a series of oiling rolls, closely spaced, thus furnishing the lubrication necessary to insure long life and continuous accuracy in guiding ways. An equipment of permanent adjustable wedges is provided for correcting the alignment after the machine has been placed on the foundation. These corrections are made at any time when errors appear, due to the settling of the foundation. The wedges are machined and rest on iron plates, which should be imbedded in the cement foundation and made to line up with a straight-edge and level. This system of adjusting blocks has been previously described in MACHINERY. (See issue of March, 1907.)

This machine has the same general features as the other Norton grinders. In the case shown, it is driven from an over-head counter-shaft, though it can be furnished for self-contained electric drive. It has no provision for grinding tapers, but it made simple and rigid, so that it may do accurate and heavy work, without the complication due to extra adjustments on the table itself. There is, however, an adjustment for the foot-stock to correct the alignment of the centers in case of any wear in the center points. The grinding wheel of this machine is furnished in various widths (from 2 to 4 inches) to suit various kinds of work; it is 24 inches in diameter. The machine will use 20 horse-power to good advantage. From 5 to 20 horse-power should be reckoned on in installing the machine, the amount depending on the character of the work to be produced, and the ambition of the operator.

The smaller sizes, that is, from 96 to 120 inches length betwen centers, are designed for the grinding of rolls and similar work.

ELECTRICAL FAULT FINDER FOR DETECTING GROUNDS, SHORT CIRCUITS, ETC.

A new and useful instrument has recently been brought out by the Electrical Controller & Mfg. Co., of Cleveland, Ohio. The makers call it a "Fault-Finder." It is intended to be used in detecting and locating grounds, short circuits, open circuits, leaks and other faults in armature and field coils, control circuits, switchboard wiring, or any other electrical connection. It will not only indicate trouble, but will locate it as well. In the case of a motor armature, for instance, a faulty coil can be accurately located and the nature of the trouble defined. If the coil is damaged, the layer in which the fault lies can be determined. In a bunch of control wires in a multiple unit train control or other magnetic switch control, the faulty wire or pair of wires can be promptly located and the nature of the fault quickly found. The instrument consists of a small box, provided with a strap for carrying over the shoulder when testing motors in inaccessible places, such as under cars or on electric over-head traveling cranes. From this small box, leads are connected to telephone receivers (either one or two, depending on the noisi-

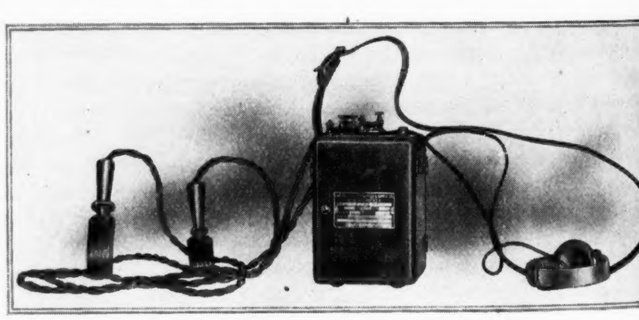


Fig. 1. Device for Detecting Faults in Electrical Connections.

ness of the surroundings) fitted with a head piece so as to leave both hands free for testing. The rheostat may be adjusted to give a sound of any magnitude from a very loud one, more than a normal ear can stand, down as faint as may be desired. Leads extend from the box also to the two test terminals.

This device is inexpensive, small and portable, and requires no outside current to operate it. But one man is needed to operate it under any conditions, so there is no excuse for the tester's desiring a helper. The manufacturers have prepared a neat booklet describing the instrument and giving instructions for its use; this will be sent on request to interested persons.

BLISS TRIPLE-ACTION DRAWING PRESS.

We show herewith a drawing press, placed on the market by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., in which three sliding motions and a knock-out arrangement are so combined that work formerly done in two operations may now be done in one. This does away entirely with rehandling and annealing first operation shells, inasmuch as the second operation immediately follows the first, making the second draw while the metal is still warm.

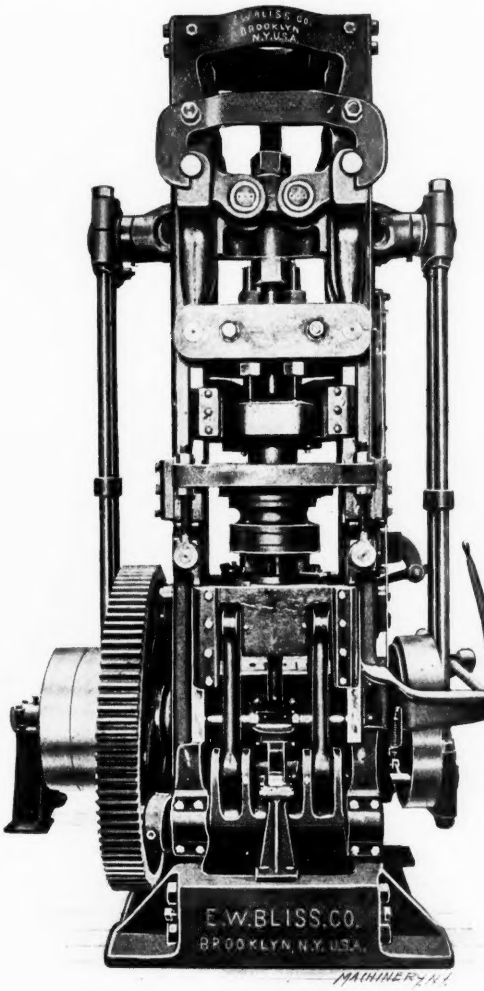


Fig. 1. Triple-action Press by means of which Two Drawing Operations are performed at Each Stroke of the Machine.

In this press, the dies and the blank placed on them are carried by the lower table, which is raised by the toggle movement shown at the base of the machine to meet the stationary blank holder, supported by the sides of the press frame. Projecting through this stationary blank holder are two plungers, one within the other, of which the outer or first operation plunger is operated by a lever movement which gives it a dwell, independent of and succeeding that given to the lower table, while the inner or second operation plunger is operated by the cranks and connecting-rods shown at the sides of the machine.

In performing a drawing operation, the movements are as follows: The blank is laid on the die carried by the lower table. This is raised by the toggle movement, holding the blank between the die and the stationary blank holder, dwelling there while the first operation punch (the outside plunger) comes into action and makes the first draw. This plunger is then given a dwell by the lever mechanism which operates it, so that it acts as a blank holder for the shell in the second operation. This second operation is performed by the smaller inside plunger, which redraws the shell through a second opening in the die. The parts now all separate, and the knock-out comes into action, ejecting the blank so that it may be easily removed.

This press is of very compact construction, and occupies no more room than any double action machine of the corresponding size for second operation work. The floor space occupied over all is 9 feet 3 inches from front to back, and 10 feet 11 inches from right to left. The height from the top of the frame to the floor is 15 feet 9 inches. The machine is geared in the ratio of 21½ to 1. The fly-wheel is 54 inches in diameter and 8 inches face, weighing 2,300 pounds, while the weight of the whole machine is 60,000 pounds. This machine is another evidence of the tendency in sheet metal working to combine operations, and reduce the number of handlings and annealing required for doing a given piece of work.

THE VIXEN MILLING FILE.

In the March, 1907, issue of MACHINERY, was published a brief description of a file of European origin, in which the teeth were of circular shape, and were cut out of solid metal, instead of being raised by chiseling as with the usual process of file cutting. This file is now introduced to the American market as a commercial product under the name of the "Vixen" patent milling file. It is sold by the National File & Tool Co., 205-206 The Bourse, Philadelphia, Pa.

As may be seen in the half-tone, the teeth have a circular form and are cut unusually deep. This form makes them self-clearing—a great advantage, especially on soft metals.

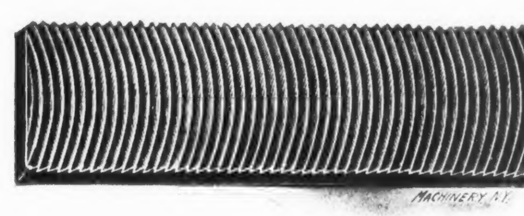


Fig. 1. A Smooth Free-cutting File in which the Teeth are cut out of Solid Metal.

The file cuts equally well on soft or tool steel, cast or wrought iron, bronze and other hard metals, and, in addition, will cut brass, lead, aluminum and other soft metals without clogging. It is also useful as a wood or farrier's rasp, as well as for slate, marble, etc. Although its capacity is higher than even a tool of the rasp or bastard order, it does its work with such smoothness and precision that in spite of its great capacity for removing metal, it is adapted to the finest work as well. This is largely owing to the manner in which the teeth are cut, they being left with true, even cutting edges, which leave a smooth surface, producing curling chips more like that resulting from a true cutting action, than that of the ordinary file. The shape of the teeth is such that the file works as well on a greased surface as on a dry one.

The first cost of the Vixen file is somewhat greater than that of the older variety, but it is asserted that on account of the enormuos amount of work it will do and its long life, it is very much the cheapest file on the market. Besides this, it may be resharpened four times, each operation costing about half that of the re-cutting of the ordinary file, and after each resharpening the file is again quite as good as new. In addition to the special shape of the teeth, the capacity of the file is increased by the special process of hardening which is followed, as well as by the high quality of the steel from which it is made. This steel is a special preparation, obtained after exhaustive experiments. The file is made with 9 teeth to the inch for regular work and

12 teeth to the inch for fine work. The latter ranks with the "smooth" file in the matter of finish, though it greatly exceeds it in the ability to remove metal.

WALCOTT 16-INCH ENGINE LATHE.

The new engine lathe built by the Walcott & Wood Machine Tool Co., of Jackson, Mich., is intended to be a plain manufacturing tool, in which the points specially looked out for are stiffness and cutting power. The accompanying half-tone illustration, and the line drawing showing a section through the head, and feed mechanism, will enable the reader to judge as to how nearly these requirements have been filled.

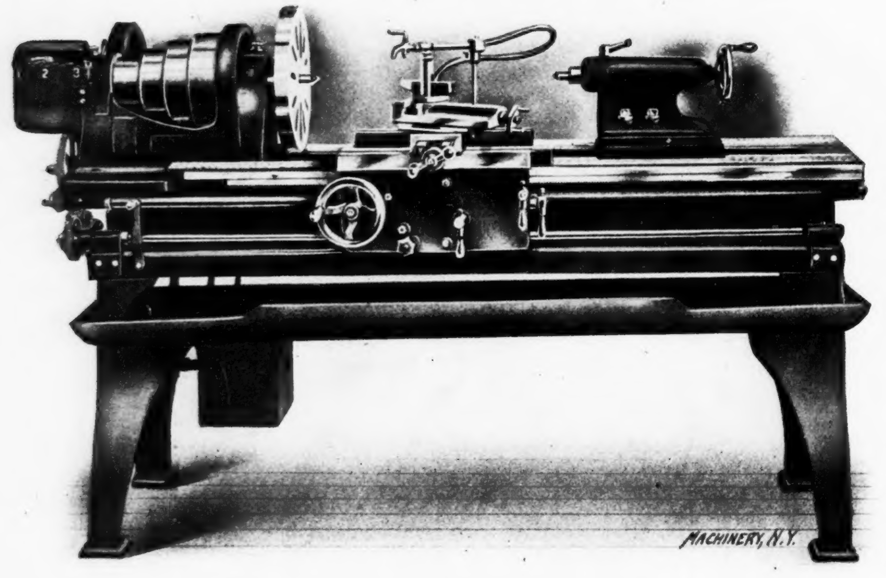


Fig. 1. The Walcott 16-inch Engine Lathe.

As is required for modern conditions, the bed is deep and cross-ribbed at short intervals throughout its entire length. The head-stock is of heavy section, and is rigidly bolted to the bed. A 4-step cone is used, the largest step being 9⅜ inches in diameter and 2 9/16 inch face. The spindle is of high carbon steel, ground, and with a 1 1/16-inch hole through its center. The bearings are of the best phosphor bronze, provided with ample oiling facilities and adjustable for wear. The thrust is entirely taken up at the rear bearing.

Perhaps the principal feature of interest, so far as mechanism is concerned, is the arrangement of the feeds. As may be seen in Fig. 2, the rear end of the spindle is extended to support the triple sliding gear *A*, which, by means of lever *B*, may be shifted to either one of three positions to mesh with gears *C*, *D* and *E*, respectively. These last gears are keyed to sleeve *F*, which runs loosely on stud *G*. For screw cutting, the intermediate gear *H* on quadrant *J* is engaged with pinion teeth cut on the inner end of sleeve *F*, and with the proper change gear *K* on lead-screw *L*. For left-hand threads, intermediate gear *M* is interposed between *F* and *H*. There is nothing to correspond to the tumbler gears of the usual lathe, as the changes for direction of feeds are effected in the apron. For any given change gear at *K*, three threads are available, depending on which of the three positions handle *B* occupies. The thread cutting index provided indicates the position of *B* as well as the change gears used.

While this quick-change apparatus extends the range of screw cutting, it was not primarily designed for this being intended rather for giving a quick control of the feed. When feeding, gear *N* on lower quadrant *O* is thrown into mesh with intermediate gear *H*. To the inner hub of *N* are keyed two gears *P*, meshing with corresponding gears *Q*, which run loosely on the splined feed rod *R*. In recesses in the hubs of gears *Q* are formed clutch teeth, which may be engaged by a clutch blade between them, and manipulated through a sliding collar and an internal rod by hand lever *S*. Two changes of feed are thus obtained, which, combined with the three controlled by lever *B*, gives six in all. This is sufficient for the ordinary range of manufacturing, and makes the machine well adapted to the general run of work, quick change of feeds being much more important in this respect than quick changes for screw cutting.

The carriage is strongly constructed, and has a bearing 22 inches long on the ways. It is securely gibbed to the bed. The longitudinal and cross feeds are driven as explained by the feed rod, independently of the screw. The apron, which is securely bolted to the carriage, is provided with gearing of ample face and pitch to withstand coarse feeds. There is no friction engagement, the drive being positive. Both the longitudinal and cross feeds are reversed in the apron, and the mechanism is so interlocked that the two cannot be thrown in together. The handles and hand-wheels for controlling these, together with those for the clamping arrangement and the throwing in of the half nut for thread cutting, are all on the front of the apron, within easy reach of the

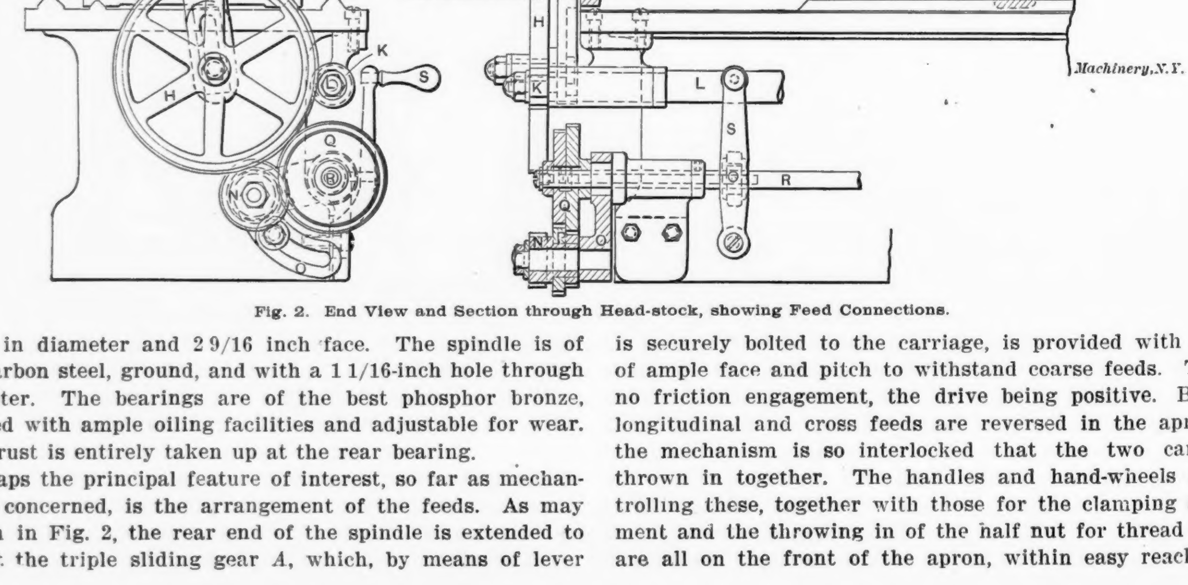


Fig. 2. End View and Section through Head-stock, showing Feed Connections.

operator. The gearing of the apron is so arranged that one turn of the hand-wheel moves the carriage approximately one inch. This is very convenient in thread cutting, as the lathe can be stopped and the carriage moved back by hand a suitable number of whole turns of the hand-wheel. This being done, the lead-screw nut can be thrown in with the assurance that the threads will match up in the right place.

Special attention is given to the workmanship of these machines, and they are sent out guaranteed to show correctness of alignment within 0.002 inch, in both cross and longitudinal feeds. The beds are made from 6 to 10 feet long, as desired. The 6-foot bed will take 3 feet 3 inches between the centers. The regular equipment includes large and small face-plates, steady and follow rests, compound rest, full set of change gears for cutting threads from 3 to 36 per inch, counter-shaft and wrenches. At extra cost, the lathe will be furnished with an oil pan and pump (as shown in the engraving), or with a taper or relieving attachment.

KIRK STOVE-PIPE ELBOW MACHINE.

The three half-tones shown herewith illustrate an ingenious machine invented by Mr. N. C. Kirk, of Chattanooga, Tenn. The purpose of the machine is the forming of elbows

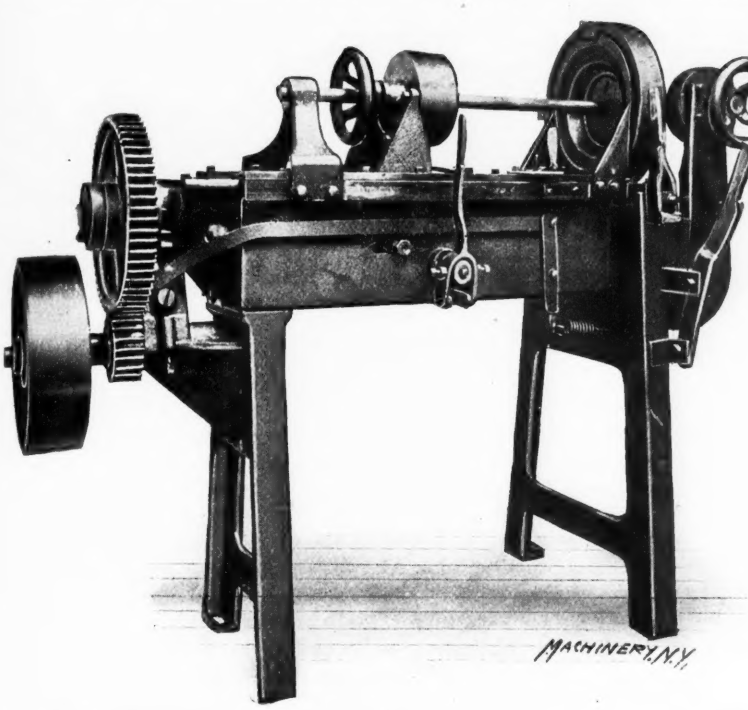


Fig. 1. A Machine for Forming Ribbed Stove-pipe Elbows by the Rolling Process.

in stove-piping by the crimping process. Unlike other machines for the same work, there are no reciprocating movements whatever in the mechanism, the whole process being

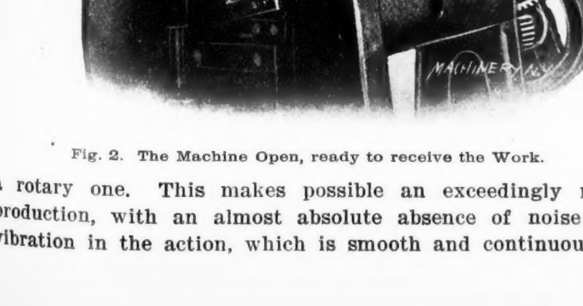


Fig. 2. The Machine Open, ready to receive the Work.

a rotary one. This makes possible an exceedingly rapid production, with an almost absolute absence of noise and vibration in the action, which is smooth and continuous.

Fig. 1 shows a general view of the machine, Fig. 2 shows the machine with the work in place ready to commence the

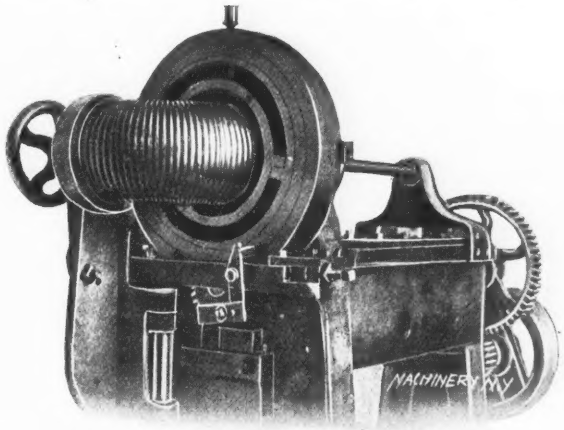


Fig. 3. Appearance of Work at the Completion of the Operation; note the Swinging Chuck which forms the Elbow to the Desired Radius.

operation, and Fig. 3 shows the work completed. The power is applied to the pulley shown at the rear of the machine, which, through suitable shafting and gearing, drives a spur gear mounted in the head. This spur gear has an eccentric seat, in which is mounted, on roller bearings, the ring which forms the grooves, the position of this ring being eccentric to the outside of the gear wheel by the depth of crimping required. At each revolution of the gear a crimp is formed. The fact that the crimping ring is mounted on roller bearings, allows it to roll in contact with the work instead of rubbing over it, preventing the shearing action that would otherwise take place.

The work itself, as shown in Figs. 2 and 3, is held at each end by conveniently operated chucks, so that it does not revolve. The inner chuck is mounted on the sliding bar, while the outer one moves on a swinging support whose radius is equal to that it is desired to give the completed elbow. During the feeding of the pipe, the rear chuck slides on the bar, and the outer chuck swings about its pivot. The feeding is accomplished by the action of the crimping ring, whose axis is set in a position out of parallel with the axis of rotation of the gear which drives it. This angular setting, combined with the rotation, causes the rolling to take place in a helical line around the pipe, advancing the latter a uniform amount for each revolution.

To form an elbow, the operator swings the hinged support with its outer chuck and hand-wheel around in position to receive the end of the blank pipe, which has been slipped through the housing and into the chuck. The two ends are then made fast in inner and outer chucks (the latter being swung in for the purpose) by a slight turn of the hand-wheels. The machine is now started up, and the continuous helical crimp is formed, the pipe being fed out along the desired curve as the operation proceeds. When the correct curvature has been formed, the machine stops automatically with the crimping ring in position to receive another blank, in which position the finished elbow may be easily removed.

DRESES 48-INCH RADIAL DRILL.

The 48-inch radial drill built by the Dreses Machine Tool Co., of Cincinnati, Ohio, has been redesigned throughout, but with particular reference to the driving mechanism. The back gears and clutches for stopping and reversing are now mounted on the spindle head instead of on the arm at the back of the column. This makes it possible to arrange the controlling handles in considerably more convenient locations for machines of different sizes than was previously possible,

and at the same time permits the use of high-speed shafts with low torque to a point in the drive very close to the drill itself. Other features of the machine are the double column with the stationary stump carried very nearly to the top of the outer sleeve, and the gear box which, in combination with the back gears, gives 14 rates of speed, and may be changed with ease while the machine is running. This is due to the fact that the variable speed shaft, if not connected with a higher speed, runs constantly at a speed determined by the lowest ratio of the change gears. The pilot wheel for the quick return movement has four handles, any one of which may be used as a lever for operating the clutch connecting the worm-wheel with the pinion shaft. The machine gives a general appearance of ruggedness and extreme simplicity, especially when the number of movements and adjustments provided, is considered.

LANCASTER OVAL TAPER DRILL SOCKETS, AND LATHE ATTACHMENT FOR PRODUCING THEM.

The Lancaster Machine & Knife Works of Lancaster, N. Y., is selling a new style of twist drill socket which, it would appear, overcomes most of the difficulties met with in driving taper shank twist drills. The great difficulty in doing this,

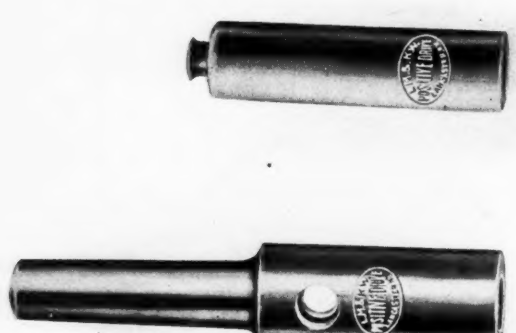


Fig. 1. Lancaster Oval Taper Drill Sockets, which obviate the Use of the Tang.

as is well known, is in preventing the tang of the drill from twisting off under the heavy service to which these drills are subjected under modern conditions and with modern tool steels. In the case of the Lancaster socket, the taper shank of the twist drill is oval in section throughout its length, and fits accurately a corresponding taper oval hole in the socket. When so made, there is no way for the drill to slip, the only possible accident being the breaking of the drill itself, due to an over strain.

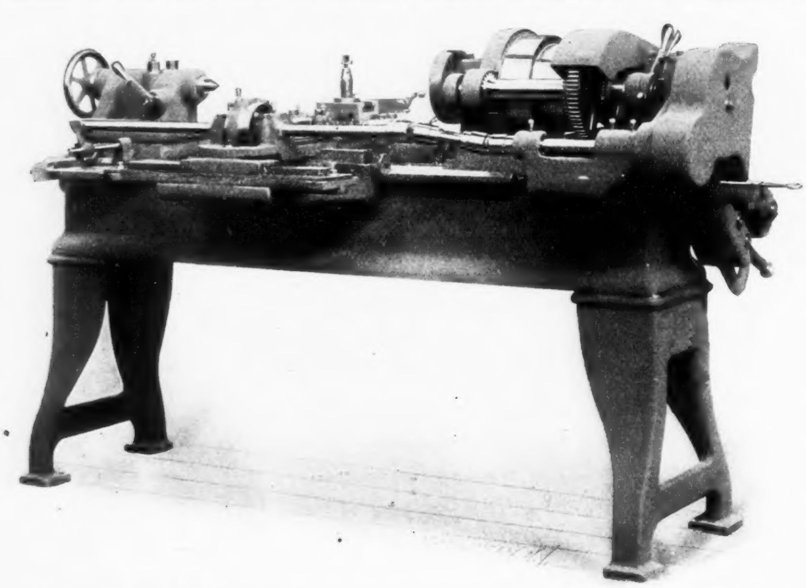


Fig. 2. Lodge & Shipley Lathe fitted with the Lancaster Attachment or Turning and Boring Ovals and other Irregular Shapes.

In the upper part of Fig. 1 is shown a reducing socket with an external and internal taper, both oval in section. A knock-out pin is provided, as shown, for forcing out the drill from the socket without injuring it by raising a burr or otherwise. The lower socket is provided with a shank and is of the usual form, the drill being removed by a drift inserted in the cross hole.

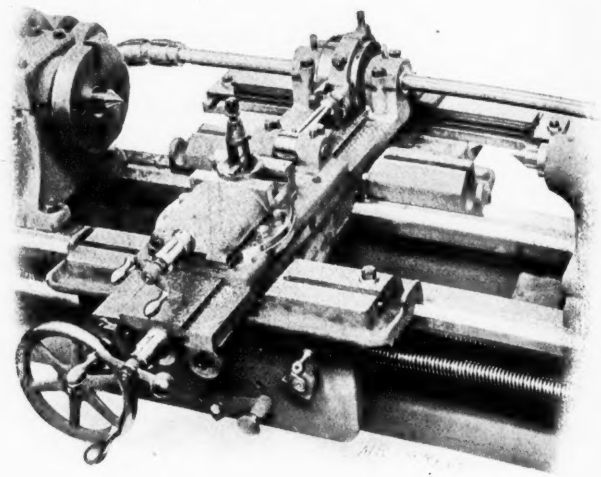


Fig. 3. Rear View of Lathe fitted with Irregular Turning and Boring Attachment.

A lathe built by the Lodge & Shipley Machine Tool Co. and equipped with a Lancaster attachment for turning ovals and other odd shapes, is shown in Figs. 2 and 3. The taper sockets are produced on lathes so arranged. The device consists essentially of a shaft carried in bearings at the rear of the bed, connected on one side by change gearing to the spindle, and on the other by a telescopic shaft to an eccentric on the cross-slide, the eccentric being arranged to reciprocate the tool-post in unison with the rotating of the spindle, thus producing the form desired. The change gearing between the lathe spindle and the attachment may be arranged in the ratio of 1 to 1 for eccentrics, 2 to 1 for ovals, 3 to 1 for 3-lobed cams and 4 to 1 for square sections. Increased ratios may be used for polygons of greater numbers of sides. The eccentric is double, the inner and outer members being rotatable on each other so as to vary the throw at will from zero to ½ inch. A graduated disk is provided showing the throw obtained. For special work special eccentrics may be provided for any desired travel of the slide. Solid eccentrics (not adjustable) may be substituted for the arrangement described above for producing duplicate work in quantities.

The tool-post is mounted on a supplementary slide, dovetailed to the carriage, and under the control of the taper attachment. This supplementary slide has cast to it brackets for the bearings of the sleeve on which the eccentric is mounted. The eccentric rod reciprocates the tool-slide, on which the tool-post may be adjusted to the diameter of work required. The main cross-slide screw operates the supplementary slide.

The lathe shown is equipped with a taper attachment. For round taper turning, the driving shaft of the attachment on the back side of the lathe is disconnected from the spindle, while for plain straight turning the block is disconnected. When this is done the lathe may be run as an ordinary engine lathe. When boring or turning to shape, and using the forming device with or without the taper attachment, the work is done with the same precision and with as little extra care is in turning or boring round surfaces, the whole mechanism being positive and taking care of itself without attention. All the wearing surfaces of this attachment are provided with ample oiling facilities. A depth gage is fitted to the compound rest screw, so that all diameters can be easily and positively duplicated in boring or turning. A gage is furnished for locating the point of the tool for all cutting conditions.

Besides the sockets shown in Fig. 1, other examples of the use of the attachment are shown in Fig. 4. These examples include a series of oval taper shank sockets, inserted one within the other, and a 3-lobed coupling joint, which may be used in the same way as the universal joint common in rolling mill practice. The builders claim that the device is applicable to the making cf drives of all kinds, doing away with

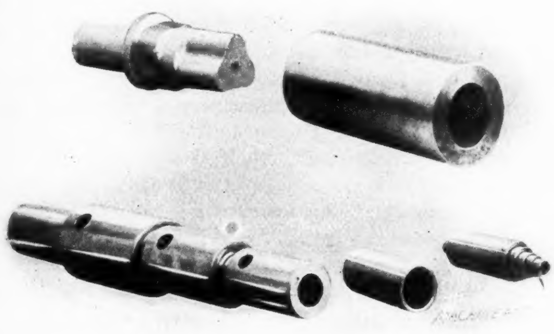


Fig. 4. Samples of Turning and Boring produced by the Attachment.

keys, set-screws, splined shafts and other holding devices. By using the squared design with the ends of the shafts tapered, a square positive coupling drive is procured, free from projecting set-screws and other objectionable features, and one that can be separated quickly and put together again without the necessity of re-facing. The hubs of gears may be bored to a square outline to fit correspondingly square turned shafts. Milling cutters, shell reamers and other tools at present held in place by keys, may also be fastened to their arbors in a similar way. This will avoid much loss from cracking in hardening, due to the weakness in this respect of the sharp corners of the key-way, as at present used.

KEUFFEL & ESSER TAPES WITH KECO FINISH.

The Keuffel & Esser Co., 127 Fulton St., New York, has recently applied a new finish to its line of steel tapes. The illustration shows their Liliput steel tape photographed to show the excellent contrast given by this new finish, known as the "Keco." It will be seen that the figures may be plainly read, the numerals and graduations standing out brilliantly and clearly upon a jet black background. Another advantage of the finish is the fact that it is not injured by exposure to

Fig. 1. The "Liliput" 25-foot Steel Tape; note the Legibility of the Graduations.

moisture, as rusting is impossible. Its brilliancy is also not marred by handling with moist hands, as is the case with many other methods of finishing.

The tape shown gives a length of 25 feet in an exceedingly small space. It is known as the "Liliput." It is provided with the maker's compensating centers, which may be adjusted for wear after long use, so as to give just the friction required for the proper winding and unwinding of the tape. This results in materially longer life for the latter.

POWER FEED FOR HOEFER 16-INCH DRILL.

The Hoefer Mfg. Co., Freeport, Ill., has recently designed a power feed for its line of 16-inch drills. This power feed is shown attached to one of these drills in the accompanying engraving. As will be seen the arrangement adopted is rather original and very simple.

The proper ratio for reducing the movement given by the driving shaft to that required for the feed, is obtained by two sets of worm gearing in series. The worm mounted on the driving shaft engages the worm-wheel keyed to the upper end of the vertical shaft, which is supported in a bearing fastened to the upper tie-bar of the frame. The lower end of this shaft carries a 3-step cone, which is belted to a corresponding cone, supported on an arm pivoted to the frame. This second cone is keyed to the shank of a worm, which engages the worm-wheel on the rack and pinion shaft. The engaging or disengaging of the worm is effected by swinging the arm on which it is mounted in towards the worm-wheel or away from it. In the engaged position it is held by a catch operated by a lever, which may be automatically re-

Fig. 1. Hoefer 16-inch Drill arranged with Power Feed.

leased by an adjustable stop on the spindle sleeve; the depth drilled with the power feed is thus automatically gaged. The tension of the belt on the cone pulleys pulls the worm out of engagement as soon as the trip is released. The rates of feed given with this arrangement for the 16-inch drill are 0.005, 0.008, and 0.012 inch per revolution of the spindles. This has proved to be a suitable range for this size of machine. The convenience of the lever feed has not been sacrificed in attaching this power connection, as the right hand is free to use the lever as before.

NOYES VERTICAL T-SQUARE.

The Emmert Mfg. Co., of Waynesboro, Pa., has undertaken the manufacture of the Noyes vertical T-square, which is shown in the two accompanying illustrations. This instrument, which is very well described by its name, comprises a T-square, guided at the top of the board, and provided with a protractor adjustable to any position along its blade. The protractor is arranged with right-angle graduated arms, so as to avoid the necessity for loose scales, thus making the device especially convenient for vertical use.

A round steel track is fastened to the top of the drawing-board. The head of the T-square forms a truck, provided with a set of four rollers which run on and are guided by this track. One pair of the rollers is beveled, and runs on ball bearings, so arranged that the weight of the head holds it down on the track with no lost motion, making possible a

very free and sensitive movement. The head also carries a spring balanced drum to which is attached a cord supporting the vertical sliding protractor, holding the latter to the blade and counterbalancing it. As the protractor is also guided by rollers, it thus has a very sensitive vertical movement. It will be seen that this combination of protractor and T-square makes provision for motion in accurate horizontal and vertical lines.

Pivoted to the sliding protractor is a forked arm, to which interchangeable scales are attached at right angles to each

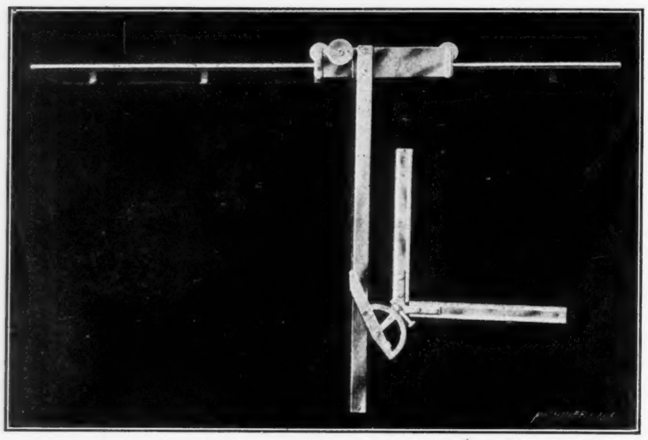


Fig. 1. A T-square which is guided from the Top of the Board and is provided with an Attached Protractor having Adjustable Scales.

other. This arm is provided with a worm, which engages notches cut on the rim of the protractor, and which can be quickly pressed out of engagement therewith. These notches are spaced 3 degrees apart, thus making possible instantaneous setting of the protractor to any multiple of 3. This includes all the most commonly used angles as 0, 15, 30, 45, 60, 75, and 90 degrees. This 3-degree angle is convenient also in that it is a common draft to give to patterns, and is suitable for the conventional angle used for showing screw threads. For the finer adjustment, the neck of the worm has a graduation of 12 divisions, each of which represents ¼ of a degree. Thus, readings are easily made to as fine a scale as ⅛ of a degree, which is as close as is ever needed in drawings. Interchangeable scales are provided which may give any desired graduations.

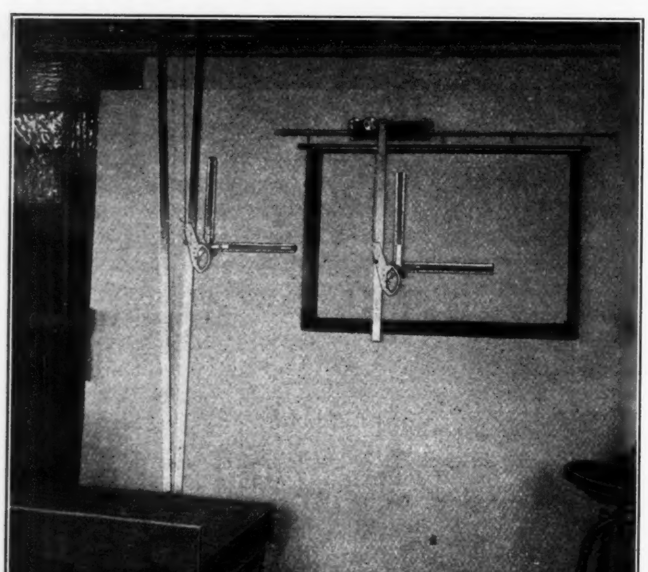


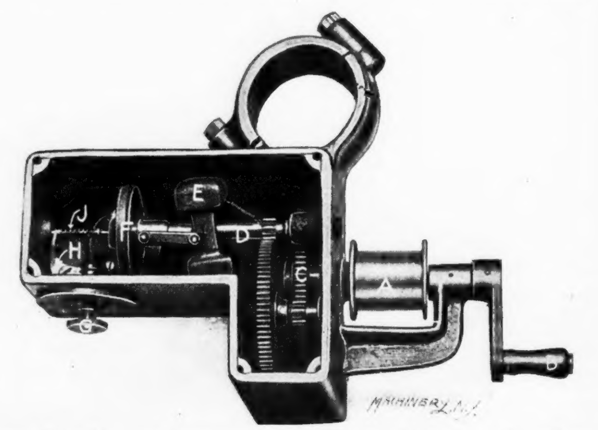
Fig. 2. Two Sizes of the T-square, showing the Application to Small Drawing Boards, and to Vertical Boards of Great Size.

Fig. 1 shows the instrument itself, which may be seen applied to the smaller board in Fig. 2. In the latter illustration is also seen a modification of the T-square for use with boards of large size, that in question accommodating a drawing 6 x 10 feet. The use of such boards is a great convenience, as it is possible to make full-sized drawings of a large machine with the same ease, accuracy and speed as on a 24 x 36-inch board. Full sized assembled drawings, with each part standing in its natural and normal life-sized position, furnish almost the same advantages as a model. With such a layout the location of the operating mechanism and the handles can be tried, and their convenience and accessibility can be determined. A more accurate scale layout is always possible also when a full-size scale is used.

The use of the instrument is by no means confined to the vertical position, it being equally suitable for use on smaller boards in the ordinary horizontal or inclined position. One of its greatest conveniences, however, is the fact that it may be so readily used on the vertical board as to do away with the inconvenience of holding triangles, scales, etc., on the awkward vertical surface, all these instruments being combined in this one. The advantages of the vertical board are thus made available. Owing to the vertical position of the T-square, it may be made much shorter than when it is guided from the left-hand side of the board, thus resulting in greater accuracy. The device does not take up much room outside of the board, it being necessary to extend the track beyond its ends but a few inches.

GOVERNOR FOR BUCKEYE BLUE-PRINTING MACHINE.

The Buckeye electric blue-printing machine manufactured by the Buckeye Engine Co., Salem, Ohio, is of the type in which the tracing to be copied and the blue-print paper are wrapped around a stationary vertical glass cylinder and held there by a convenient rolling curtain while an arc lamp is



Blue-printing Machine Governor for Controlling the Movement of the Lamp.

lowered through the center of the cylinder at the proper rate to give the length of exposure required to make the desired print. In the older machines, with which most of our readers are familiar, the rate of descent of the lamp and the consequent length of exposure of the sensitized paper was regulated by an adjustable pendulum controlling an escapement, the whole being operated by the weight of the lamp. This device has been superseded by the mechanism shown in the accompanying engraving, which employs a governor to give the speed of descent required.

The cord which supports the lamp is wound around drum *A*, which, with the attached crank, serves as the means for raising the lamp at the conclusion of the exposure, in preparation for a new one. Inside of the casing shown, and mounted on the same shaft which carries drum *A* and crank *B*, is a gear *C*. This, through the intermediate gearing, rotates governor spindle *D* at a considerable velocity, the ratio of the geared connection being high. The governor *E* consists of a double weight, connected with arms, and pivoted at center of the spindle. Normally the spring at the right of *E* draws the governor to the outward position, pressing disk *F* (by means of the links shown) down against a bearing in a stationary bracket at the left, which also serves as the outer bearing for the shaft. Disk *F* being splined to the shaft, the friction between it and the stationary surface, under the influence of the spring, is sufficient to prevent the rotation of *D*. The lamp is thus held in a stationary position. On the front of the case is a knob *G*, provided with a pointer indicating graduations on the circular dial shown. *G* is connected to a small worm which meshes with seg-

mental worm-wheel teeth cut in the lower arm of lever H. The upper arm of this lever encircles a push-rod J, and bears on the lower end of the coiled spring shown mounted on it. J passes through the stationary friction bracket into a hole in spindle D, where it bears against the cross-pin by which the links are fastened to F, and by which F is keyed to D.

It will be seen that the spring on J tends to force F away from its stationary seat against the influence of the spring attached to E, and that this pressure may be varied by the manipulation of knob G. When the pointer on G is set at zero, the spring on J is released, and that attached to E has its full effect in preventing rotation of the parts. As the pointer is turned around to increase the pressure of spring J, F is raised further from its seat, allowing the spindle to revolve until it has attained such a speed that the governor again forces the disk down to its bearing.

The rate of movement of the lamp will thus be maintained at a point corresponding with that position of the governor balls which just barely allows the friction surfaces to rub on each other, with the spring pressure provided. This spring pressure may be varied by knob G, which consequently furnishes a means of adjusting the speed. The dial permits the determination of the proper rate of printing for any given paper and given conditions. This rate may be duplicated with certainty at any time without having to go to the trouble of making trial printings.

This device gives a greater variety of speeds than the older method, being capable of the most minute adjustment. It is noiseless and eliminates all jerk and jar from the lamp, thus greatly increasing the life and efficiency of its mechanism. The whole apparatus is enclosed, free from dust and dirt, in an iron box, which is clamped to the frame of the blue-printing machine at any height to suit the convenience of the operator.

AN ADDITION TO THE SLOCOMB LINE OF MICROMETERS.

The accompanying illustration shows six new micrometers which have been added to the line made by the J. T. Slocomb Co., Providence, R. I. They measure all sizes from 13 to

Set of Slocomb Micrometers, measuring from 13 to 19 Inches.

19 inches, inclusive. The heads are provided with the well-known adjusting arrangement provided with all of this line of micrometers.

The six instruments are furnished with the stand shown, which will be found very convenient for use in the tool-room, a board being provided with hooks for checks, to indicate the numbers of the workmen who borrow them. The base of the board forms a compartment for a set of end measures from 13 to 18 inches, increasing by 1-inch steps. They are 7/16 inch in diameter, and are fitted with rubber grips to avoid changes in length due to the heat absorbed from the hands in making measurements.

American Gas Furnace Co., 24 John St., New York. Gas furnace for hardening with barium chloride. This furnace is especially adapted to the use of this form of hardening bath. The crucible is set into the furnace and sealed, in such a way as to prevent the gas flame from attacking the liquid in the crucible, and thus generating noxious fumes.

John H. Dorman, 1 Bethune St., New York City. Tapping attachment for use in sensitive drill presses. It will drive taps up to and including ⅜ inch in diameter. A stop is provided which, when the desired depth of tapping has been reached, reverses the spindle and backs the tap out. A friction device has been incorporated in the attachment.

Cleveland Automatic Machine Co., Cleveland, Ohio. Motor drive for screw machines. This company provides its screw machines, if required, with motor drives entirely self-contained. The motor is placed at the end of the machine, four posts extending upward from the corners of the frame for the support of the counter-shaft to the machine, which is thus independent of any hangers on the ceiling.

Western Rail Supply Co., Chicago, Ill. Pneumatic vise of simple and rigid construction. On account of its quick and reliable control it can be used not only as a vise, but as a metal former, punch or forcing press, shear, riveting machine, or bull-dozer. The air-cylinder is cast solid with one jaw and the base of the vise. The piston rod is a solid casting carrying the other jaw of the vise.

The Cincinnati Shaper Co., Cincinnati, Ohio. Heavy 24-inch crank planer. This machine is driven by a positive crank motion of Whitworth type so as to secure a quick return. The cross rail is provided with a head which swivels on each side of the vertical, the angle being read from graduations in degrees. The machine will plane 20 inches high, 20 inches wide and has a 24-inch stroke. It is built with a solid base resting on the floor, and weighs 5,500 pounds.

Joseph T. Ryerson & Son, Chicago, Ill. A portable automatic key-seating machine, especially designed for cutting key-ways in locomotive axles, either before or after the engine has been assembled. This machine is operated by an air drill or electric motor, as most convenient. An end mill is used, carried by a slide which reciprocates continuously over the length of the key-way, while the mill is slowly fed in until the desired depth has been reached.

The Westinghouse Traction Brake Co., Pittsburg, Pa. A line of belt-driven air compressors for industrial service. These compressors are made in four sizes, having 15, 26, 44½ and 54½ cubic feet of free air per minute capacity, respectively, at standard speeds. The horse-power for these sizes at 100 pounds pressure is 3, 5, 9 and 11, respectively. They are provided with water jackets, but may be operated without if required. This compressor is of the duplex, horizontal, single-acting type, and is easily portable.

Bardons & Oliver, Cleveland, Ohio. Motor driven brass working lathe, in which the motor is mounted directly on the spindle. The controller provided is of the reversible drum type, and has an automatic brake, so that the lathe is brought to rest as soon as the power is shut off, though the controller may be set to allow the spindle to be easily turned by hand when desired. The spindle is reversed by the controller for threading in less time than is possible with a belt. Twenty changes of speed are provided, ranging from 300 to 1,400 revolutions per minute in either direction.

GRAPHLIO—A NEW GRAPHITE PRODUCT.

A new form of graphite has been placed on the market by Walter D. Carpenter Co., 39 Cortlandt St., New York. This product is of crystalline structure, but ground to a degree of fineness hitherto unattained except with the amorphous form of the same material. The superior toughness and adhesiveness of the flake or crystalline condition make it very difficult to grind, and it is claimed that until recently it has been impossible to reduce it to the impalpable powdered form which would be most effective for practical application. In grinding the graphite to this condition the operation introduces into the material a considerable quantity of fine grit—waste from the stones used for producing the material. Only a part of this grit could be removed, the process usually adopted being that of "blowing," on the same principle that chaff is separated from grain by winnowing. By a process developed by the manufacturer of Graphlio, the grit produced by grinding this tough flaked graphite to an impalpable powder is so fully gotten rid of that it is impossible to detect its presence in the finished product, thus making a very superior article for the lubrication of the finest and most closely fitted bearings.

Still another characteristic of Graphlio is the fact that it has been so treated that it will remain suspended in light oil practically indefinitely, and thus may be used in any system of oil piping or lubricators already installed, without requiring any special appliance to be furnished for using it. This permits also the continuous application by sight devices, instead of requiring a troublesome periodical application by force pump or otherwise. It is of the highest commercial purity, containing about 95 per cent carbon and 5 per cent silicate, having thus in a high degree the characteristic advantage of the crystalline over the amorphous form—the latter having usually a large proportion of foreign substances combined with it (such as clay) which it is difficult, if not impossible, to remove. Particular attention is called to its freedom from grit. This may be tested by rubbing a small quantity of it on a hard surface, like a glass plate, with a paper knife or any other convenient implement. The substance is so inexpensive that it adds very little to the cost of a gallon of oil, while it is said that its use will decrease the amount of oil used from 40 to 50 per cent, thus resulting in a marked saving in the cost of lubrication.

* * *

As an interesting example of the working of the true mathematical mind, the case of Prof. Akerlund, of the Boras Technical College, Sweden, who lately died, may be mentioned. In many particulars this man resembled Lord Kelvin, and he was well known in mathematical circles in Scandinavia. His former instructor in mathematics stated that, while at high school, after the first principles and the object of trigonometry and analytical geometry had been verbally explained to him, he worked out and became proficient in the fundamental theories of these two subjects without the aid of any textbooks whatever. While at the university he studied philosophy, but as a true mathematician he would accept nothing which he did not understand, and as he found that the learned text-book in logic used there was beyond his own comprehension, he would not admit that it was founded on real logic, and finally made the professor of the subject himself admit that he, too, did not comprehend the particular subject as taught. This is the supreme test of the true mathematician. He accepts nothing as fact unless he can comprehend or prove it. In this connection it may be interesting to note that Akerlund, while still at school, constructed an electric motor simultaneously with Gramme. Gramme, however, brought his invention first before the public eye and consequently the credit of being the inventor of the electric motor has been accredited to him.

* * *

Commencing October 1, the postage rate on letters mailed in the United States addressed to places in Great Britain and Ireland, will be 2 cents per ounce or fraction thereof. Letters mailed without postage will be forwarded to their destination, but double the deficient postage calculated at the 2-cent per ounce rate will be collected from the recipient upon delivery.

AN AMERICAN MECHANIC IN EUROPE—6.

A SERIES OF LETTERS FROM OSKAR KYLIN ON THE EDITORIAL STAFF OF MACHINERY.

STOCKHOLM, SWEDEN, August 12th, 1908.

The commercial situation in Sweden at the present time appears to be somewhat discouraging. The wave of industrial depression which began last fall in the United States, reached Sweden later than the larger European countries, and consequently the improvement in conditions will doubtless commence somewhat later as well. The machinery dealers who handle largely foreign machines—American, English or German—feel the depression most keenly. The Swedes are patriotic by nature, and, therefore, prefer to buy the products of home industry, other conditions, such as price, quality, etc., being about equal; as a consequence, the importers of foreign products received the first and hardest shock in the financial and industrial depression. The greater number of the works visited here are still working full time, though some of them are building for stock.

The industrial depression in Sweden has, however, also a local cause. The labor unions have during the last few years become very powerful and have time and again, with more or less success, tried to better the conditions of the working people. This summer a dispute arose between the men and employers in some shops, and a strike was declared. The questions involved were rather complex and it appeared at one time as if all the Swedish industries would be drawn into the conflict, and the Employers' Association threatened a general lockout affecting the whole organized force of labor of the country. At the very last moment, however, this extreme step was prevented, and temporary peace, at least, restored. The feeling of unsafety which this state of affairs naturally brought about, had a very demoralizing influence on industry in general, and firms neither dared to take or place an order. The restored peace, however, it appears, has also restored confidence, and already signs are visible of a considerable revival in the industries.

The sales of American machine tools in Sweden are stated to be on the decrease as compared with the sale of other machine tools. Germany, being near to this territory and being in possession of a better knowledge of local conditions, is a very able competitor with America; and the Germans also have the advantage of shorter shipping distances, and can, consequently, deliver their machines more promptly, and, at the same time, the freight charges are smaller. English machinery is also sold to quite a large extent in Sweden, and the competition on the part of the home manufacturers is making itself more and more keenly felt. A few Swedish machine builders are beginning to specialize on standard machine tools to a considerable degree.

Noteworthy Swedish Works.

The largest of the works located in Göteborg is Lindholmen's Mekaniska Verkstad. These works are largely devoted to the shipbuilding trade, and are equipped with some very large docks for the purpose. Many of the vessels for the Swedish navy are built here, and one was under construction at the time of the writer's visit to the plant. The shops are also equipped for building engines and boilers, and for sheet metal work in general. The boiler department is well up to date and equipped with the most modern machinery, but the machine shop is less modern. The most notable work in the hands of the company at this time, perhaps, is the construction of one of the large railway ferryboats ordered by the Swedish government for the traffic between Sweden and Germany. This boat, which is to ply between Trelleborg, Sweden, and Sassnitz, Germany, a distance of some 65 miles, has a capacity of from 15 to 18 railway cars in addition to spacious accommodations for the passengers. The length of the ferryboat is 348 feet, the width being 48 feet.

One of the best-known of the Swedish mechanical works is that of Nydqvist & Holm, Trollhättan. This firm has gained a high reputation in locomotive building, most especially for the high quality of workmanship and careful design of its product. A large number, perhaps, in fact, the largest number of all the locomotives used by both the state

railways and the private roads in Sweden, are made by this concern. For some years past, the firm has also made a specialty of air compressors and pumping machinery, and is, at the present time, starting out in still another line of machine building—that of building gas engines. Sweden has no coal deposits worth mentioning, but is instead in possession of large quantities of peat. The company is now carrying on extensive experiments with a view to using peat in gas producers for the motive power of gas engines. It is stated that there have been some difficulties in connection with these experiments in regard to the gas purifying apparatus, but it is said that the company has been able to eliminate all the difficulties which have arisen; the results of the experiments, however, are still kept secret. A large new machine shop has recently been erected by the firm, which is to be used in addition to the old shops, the latter being too small for the growing business. The new shop is splendidly lighted, and equipped with up-to-date heavy-duty machine tools and large electric traveling cranes. The electric welding process is employed in these works and gives very satisfactory results. It is used largely for mending and welding castings, and it is stated that the welded joint is as strong as the unbroken piece. On account of the large amount of current consumed by the process, it is only run during the night, when there is but little load on the generators.

A remarkable piece of work now in course of construction in these works, is one of the two large water turbines, each of 12,500 H. P., for the government power generating station at Trollhättan. The utilization of the Trollhättan falls by a large government power station, which will ultimately also furnish power for part of the electrified state railways, has previously been, from time to time, referred to in MACHINERY. When complete, the present station will have 8 turbines, each of 12,500 H. P., or a total of 100,000 H. P. Only four units are, however, to be installed at the present time, and the others will be installed as the demand for power increases. The required canal, the tunnels and the buildings, are at the present time built large enough to take care of the ultimate capacity. The energy is transformed by exceptionally large generators into three-phase, 25 period, alternating current of 50,000 volts tension. The current is to be utilized partly by factories within easy reach of the power station, and partly by neighboring cities and towns for lighting purposes. In the future, of course, when the electrification of the state railroads has been carried through, the greater part of the power will be consumed by these. The power plant is planned to be ready January 1, 1910.

A concern which for some time past has been devoting itself exclusively to the building of machine tools, is Lidköpings Mekaniska Verkstad, Lidköping. While this firm largely specializes on lathes, it does not devote itself exclusively to this one line in the American sense of the word specialization, but builds also a large number of other types of machine tools, such as drills, planers, boring mills, etc. This firm's machines, although not of so highly developed design as American machine tools, are strong and powerful, and, apparently, of good workmanship.

The Motala Mekaniska Verkstad, Motala, is one of the largest works in the country, employing about 1,000 men. These works are equipped principally for the making of marine engines, boilers and locomotives, and for bridge building, and have recently commenced to develop a line of oil engines. The concern is old and well established, and commands a skilled and well-trained staff of officers and men, and to the skill of the workmen, rather than to the employment of high-grade tools, must be credited the high class of work produced. Besides the regular machine shops, there is also a small rolling mill plant largely for the individual needs of the shop, and a well-equipped forging shop for heavy forgings. The company also makes the larger portion of its own locomotive accessories.

Without question, the best and highest developed of the Swedish machine tool firms is the Köpings Mekaniska Verkstad, Köping. This is a medium-sized concern which during the course of the last few years has specialized on lathes of large and small types. The largest types of machines are usually built to order, but medium sizes are often built in lots of from six to twelve and smaller ones in lots of twenty at a time. Following the practice of most other European works, the company, however, makes also a few other machine tools, such as planers, milling machines, drills, etc., but the building of these machines is more or less spasmodic, depending upon the variations of demand in the lathe business. A very high class of machine tools is employed in these shops, and the works are conducted according to the most modern methods. Recently some of the latest styles of American grinding machines were bought and introduced into the shops, and the company is commencing to use the latest American methods in grinding; electric chucks are used to a large extent in connection with the grinding machines. An increase in trade is expected by the company in the near future, and an enlargement of the works is therefore contemplated.

A firm which is known outside of Sweden as a machine tool building firm of repute, is Nya Aktiebolaget Atlas, Stockholm. This firm has developed a number of original designs of machine tools, such as drills, milling machines, boring mills, gear-cutting machinery, etc. During the last few years, however, its manufacture of machine tools has gradually diminished, partly because of the keen German competition. The firm is still engaged in this work, but only to a small extent, its efforts being directed toward the locomotive and railway car building industry. The firm is also building steam engines, air compressors, pneumatic tools, railroad bridges, etc. On account of the high price of land in Stockholm and the consequent high living expenses and high wages, the company is contemplating moving the works to a town a few miles out from the city. The first portion of the shops will probably be moved in about a year, and the remainder later, according to the conditions of the trade.

* * *

FIRE RISK IN LOWER NEW YORK CITY.

Owing to the concentration of enormous buildings, the lower end of Manhattan Island is regarded by insurance experts as a very dangerous fire risk. Mr. William McCarroll, president of the New York Board of Trade and Transportation, has published a letter from Mr. P. F. Schofield, in which the danger is vividly pointed out. Mr. Schofield states that the area of Manhattan Island between 14th St. and the Battery is about equal to the area of Chicago, swept by the fire of 1871 in which the property loss was $170,000,000. The assessed valuation of the improvements on this section of New York is over $400,000,000, and the merchandise housed in these buildings brings the valuation up to more than $1,000,000,000. One warehouse alone in this district is said to have stored at one time merchandise valued at more than $50,000,000. It is no wonder then that the wholesale dry goods district of Manhattan is the "nightmare of the insurance world." A conflagration in this section of New York, on the scale of the Chicago fire, would wipe out property values unparalleled, and the effect of such a disaster would not be limited to the metropolis or to New York State. It would be felt in every city of the union, and in the Old World as well. The geographical situation of Manhattan Island, between two rivers, and the narrow cross streets, make the condition very favorable to the spread of a fire, especially when it is considered that winds attaining velocities of forty to fifty miles an hour in combination with a temperature below the freezing point, are not unknown. Take such a situation, with insufficient water pressure, and the possibility of a fire that would be unparalleled in property destruction in the world's history is not so remote as it might be. Should such a fire gain headway, the towering piles of architecture that dominate Broadway, and which are considered impregnable to fire would, in no small measure, add to the conflagration. The streets would be converted into artificial tunnels and canyons, acting like funnels or blow pipes to fan the flames when they had once gotten beyond the control of the fire department, and the flames would leap from building to building far above the puny streams that the fire engines and water towers could throw.

OBITUARY.

Harris Tabor.

Harris Tabor, of the Tabor Mfg. Co., died July 29, 1908, at his home in Philadelphia, his death being the result of an automobile accident which occurred on July 4 of last year. He was on his way to visit friends when the heavy machine in which he was riding was overturned by the shifting of the soil of the narrow hillside road they were following. He was caught beneath the overturned machine and seriously injured, and was confined to his bed until the first of September, shortly after which he resumed his duties at the Tabor Mfg. Co. His improvement was slow, and in March he contracted a severe cold which early in May forced him to again take to his bed. This, together with his weakened condition, brought about his death.

He was born in Clarence, Erie County, New York, on January 26, 1843. At the age of 21 he enlisted as a private in the Civil War for a term of two years. He was honorably discharged and mustered out of service at Elmira, N. Y. He began his mechanical training as an apprentice in the shop of his brother, Leroy Tabor, Sr., at Tiago, Pa., where he remained two years previous to his enlistment. After leaving the army he went to work as a machinist with S. Payne at Troy, N. Y. From there he went to B. W. Payne & Sons, Corning, N. Y., and when this company moved to Elmira, he was made superintendent. In the early 80's he moved to Hartford, Conn., to assume the position of superintendent of the Hartford Steam Engine Works. After a year here he went to Pittsburg as superintendent of the Westinghouse Machine Co., where he remained for three years. During all this time his work had been specialized in the line of steam engineering. The well-known Tabor governor and Tabor steam indicator were invented and placed on the market during this period. The former was sold to, and is now being manufactured by, the Ashcroft Mfg. Co.

While with the Westinghouse Machine Co. he became interested in foundry work, and conceived the idea of a power operated molding machine. For furthering the development of this idea, he associated himself with Manning, Maxwell & Moore, and later resigned his position in Pittsburg and took up quarters in New York, where he could give the development of the molding machine his full attention. In 1888 he placed on the market the first successful power molding machine, operated by steam, through an over-head cylinder. In the fall the manufacture of the machine was transferred to the Pond Tool Works, Plainfield, N. J., and continued there until the early 90's when the Tabor Mfg. Co. was organized, and the manufacture of the machine transferred to Elizabeth, N. J., where the vibrator system of molding and the first compressed air machine were brought out. In 1900 the greater portion of the interest of the company was sold to Mr. Wilfred Lewis, and in September of that year the plant was transferred to Philadelphia. Up to this time he had been president of the company. From 1900 to 1906 he was occupied in looking after his various interests, and acting in the capacity of consulting engineer of the Tabor Mfg. Co. In June, 1906, he moved to Philadelphia, where he again took active part in the affairs of the company up to the time of his illness. Mr. Tabor is survived by a wife.

* * *

PERSONAL.

W. E. Farrel has been elected president of the Stoever Foundry & Mfg. Co., Myerstown, Pa., succeeding Ralph McCarty, who has resigned.

Walter J. Friedlander has been made general manager of the Hisey-Wolf Machine Co., Cincinnati, Ohio, manufacturer of electric drills, grinders, etc.

Walter S. Lang, of the Glasgow branch of Charles Churchill & Co., Ltd., sails for Great Britain September 8. He has spent considerable time in this country studying American methods in a number of the prominent machine tool manufacturing shops.

Forrest E. Cardullo, an occasional contributor to MACHINERY, who was instructor of practical mechanics at Syracuse University, has resigned his position and has been made professor of mechanical engineering at the New Hampshire State College, Durham, N. H.

Edward R. Euston has been elected vice-president and general sales manager of the Stoever Foundry & Mfg. Co., Myerstown, Pa. He will have offices at 140 Cedar Street, New York City. Mr. Euston has been manager of the company's New York office for the past six years.

R. B. Anthony, graduate of University of Wisconsin; E. L. Moreland, graduate of Johns Hopkins University, and F. W. Willey, graduate of Purdue University, have received the degree of master of science from the Massachusetts Institute of Technology for post graduate work done in the electrical engineering department.

S. Coulange, for the past twelve years designer for the Fabrique Nationale d'Armes de Guerre, of Herstal, Belgium, and representative of Fenwick, Freres & Co., has opened an office in Rue Louvrex, Liege, Belgium, as a consulting, inventing and constructing mechanical engineer of machine tools and special machinery. American and foreign manufacturers are requested to send Mr. Coulange their catalogues.

B. B. Quillen, secretary and treasurer of the Cincinnati Planer Co., Cincinnati, Ohio, and Alfred Marshall, president of the Marshall & Huschart Machinery Co., with their wives and a party of friends, left Cincinnati on August 13th in automobiles for a tour through the East, and will travel through Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, visiting New York city, Philadelphia, Atlantic City, etc. The party expects to be on the road four weeks.

Arthur D. Dean has been appointed chief of the division of trade schools of New York State, the appointment taking effect September 1. This appointment is made in accordance with an act passed by the New York legislature this year authorizing the establishment of industrial and trade schools in cities and union free school districts. Mr. Dean will do much traveling throughout the State to meet boards of education and gatherings of citizens interested in promoting local trade schools and industrial education.

* * *

NATIONAL MACHINE TOOL BUILDERS' CONVENTION.

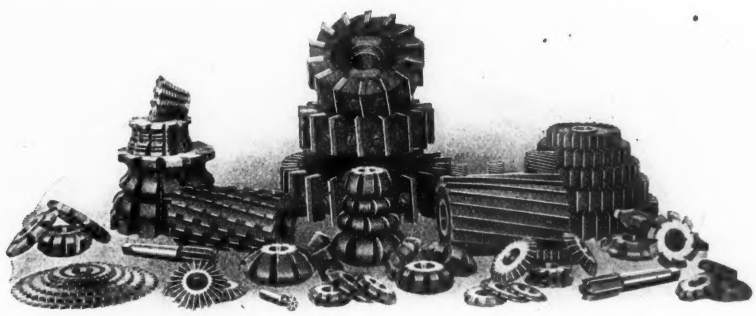
The National Machine Tool Builders' Association will hold its regular annual convention at the Hotel Imperial, corner of Broadway and 32d Street, New York, Tuesday and Wednesday, October 20th and 21st. Further information may be obtained from the secretary, Mr. P. E. Montanus, Springfield Machine Tool Co., Springfield, Ohio.

* * *

Never forget that you must begin at the bottom and not at the top if you desire results. Scattering seeds over an unprepared surface is a waste of time. You must plow first. Then the results will be in direct proportion to the persistence with which the work is followed up.—*Geo. G. Yeomans before the Railway Storekeepers' Association.*

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.



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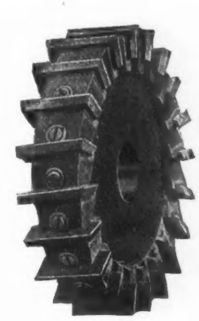

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ADVANCED DEGREES IN ELECTRICAL ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

The demand for young men with a more extended and a deeper training in electrical engineering theory than can be obtained in an undergraduate engineering course has led the Massachusetts Institute of Technology, Boston, Mass., to emphasize its graduate courses. These graduate courses lead either to the degree of master of science for young men who propose to spend one year of advanced study of electrical engineering, or to the degree of doctor of philosophy or doctor of engineering for young men who are able and propose to spend longer periods in their advanced study and research. The degrees of master of science and doctor of engineering are particularly applicable to students following electrical engineering studies, and lectures, seminars, and other advanced instruction for students who are candidates for the doctor's degree will be well under way in the electrical engineering department during the next school year. In addition to students who will follow the course leading to the degree of master of science, candidates who will follow the works leading to the degree of doctor of engineering have already arranged to begin this work at the Institute next fall. The advanced work leading to the doctor's degree may follow in its major part either the lines outlined by Professor Jackson's lectures on the organization and administration of public service companies, or by Professor Clifford's advanced course on alternating currents, as the individual student may choose, and it is expected to be accompanied by such other work as may be chosen by the individual student (subject to faculty approval) from other departments of science and engineering. It is believed by the faculty of the Massachusetts Institute of Technology, that engineering students of particular ability can well afford to spend from one to three years of special advanced study under competent instructors along the lines of engineering theory and practice, and that such students will profit largely from the results of such study. Indeed, this seems to be proved by the experience of numbers of engineering students who have gone through courses of advanced study in engineering or scientific schools either in this country or abroad. The schools of foreign countries were doubtless formerly in advance of the American schools, for the purpose of advanced study in engineering and applied science, but it is believed that this condition no longer prevails. The advanced courses in electrical engineering at the Institute are planned particularly with a view to meeting the needs of such students as have hitherto found it necessary to go to foreign countries for advanced engineering instruction.

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LUDWIG LOEWE & CO.'S SCHOOL FOR APPRENTICES.

The machine tool building firm of Ludwig Loewe & Co., Berlin, Germany, has installed in its shop a very complete apprenticeship school. There are seven different courses for apprentices, according to the work for which the young man wants particularly to fit himself. The time of apprenticeship for all-around machinists is four years, divided up between nine different departments in the shop. For tool-makers, molders, pattern-makers, lathe hands, planer and milling machine hands, and blacksmiths, the apprenticeship time is three years. The apprentices are given a rather thorough all-around experience, the lathe hands, for instance, spending three months in the tool grinding department and three months in the hardening department; the pattern-maker apprentices spending six months in the foundry, etc. Besides the practical training, the boy attends an apprentice's school within the shop in which he spends eight hours a week the first year (in the case of a four year's apprenticeship eight hours for the first two years), seven hours for the second year (or third), and six hours for the third (or fourth) year. The curriculum is made up not only of purely mathematical subjects, such as geometry, algebra, drawing, strength of materials, etc., but a general course is also included, giving the rudiments of business law, civics and political economy. Besides this, two hours a week are devoted during the last two years to the study of German. It appears that the idea of this apprenticeship school is not only to train good workmen, but also to produce men who have a broadened view of their work and their duties, and who will, if successful in their mechanical work, be able to take any kind of a responsible position around the shop that may fall to them. There is no doubt that an apprentice training planned broadly will give more satisfactory results in the long run than one planned along too narrow and specialized lines.

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ASHES FOR PILLARS IN COAL MINES.

In some of the anthracite coal mines of northeastern Pennsylvania, ashes are being used as pillars to prevent cave-ins. Flushed in the spaces formerly occupied by coal, the ashes form a solid mass when the water drains off, capable of holding up the earth and rock above. Thus they enable the miners to "rob pillars"—to take out coal which they had been forced to leave as supports. A mine just outside of Scranton, Pa., is near a big boiler plant which consumes three hundred tons of coal daily. Naturally, a large supply of ashes is created in the fire boxes beneath the boilers. It is estimated that about fifty tons of ashes a day are sent down into the mine. Water pumped from a nearby mine is used for the flushing. Running through a wooden trough, it reaches a tunnel that passes beneath the ashpits. This tunnel slopes at a grade of three-eighths inch to the foot. At intervals the ashes are shaken into it from above. The flow of the water carries the ashes to a borehole leading down through the ground to the mine. At the bottom are pipes leading to the worked-out places which are to be filled. Through the pipes goes the torrent of ashes and water, and the ashes are piled into the abandoned "breast" or gangway, while the water seeps and drains away. Gradually the pile of ashes grows, until it reaches from floor to roof. Then it becomes hard and firm. Nearby have been left pillars containing hundreds of tons of coal. When the new ash-pillars are large enough to be safe supports, the coal can be taken out. The piping is worn-out very rapidly by the sulphur which is always present in mine water and therefore has to be replaced frequently.

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INTERNATIONAL CONGRESS OF INVENTORS.

In view of the discussion that has been carried on in the columns of MACHINERY and elsewhere regarding the status of inventors and their relation to the U. S. Patent Office, it is interesting to know that an organization known as the International Congress of Inventors was established in 1906 and incorporated in 1907 for correcting present abuses and furthering the interests of inventors. Its object is to secure legislation which shall insure to the inventor the services of the patent office which his application fees should provide and protection for his inventions which a government guarantee should give. It was largely through the efforts of this association that Congress this year provided for an increased force of examiners and for an advance in the salaries of the patent office employees. An important matter now under consideration by the association is the establishment of a standard for a United States patent. The patent system purports to be a system for insuring a reward to inventors for their efforts and for stimulating the production of inventions of value to the public, but patentees and holders of patents have found that a United States patent has no definite standing until it has been passed on by the courts. Further information regarding the objects of the association can be obtained from Mr. Ralph T. Olcott, secretary, International Congress of Inventors, Rochester, N. Y.

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Experiments carried out at the testing plant of the United States Geological Survey, regarding the fuel value of Florida peat, indicate that in a gas producer plant this peat produces gas having a thermal value of 175.2 B.T.U., compared with 149.6 B.T.U. for West Virginia coals and from 141.6 to 153.2 B.T.U. for Pennsylvania coals. The amount of peat consumed per brake horse-power was 2.08 pounds as compared with 1 pound of West Virginia coal, and 1.12 pounds to 1.47 pounds of Pennsylvania coals.

NEW BOOKS AND PAMPHLETS.

SOME EXPERIMENTS IN THE STORAGE OF COAL. By E. A. Fessenden and J. R. Wharton. 24 pages, 6 x 9 inches. Published by the University of Missouri, Columbia, Mo.

This little pamphlet is No. 1 of the Engineering Series of the Bulletin of the University of Missouri, and contains an interesting report of tests and experiments regarding the storage of coal, carried out at the University of Missouri. Explanatory illustrations and diagrams are included.

THE SLIDE RULE. A PRACTICAL MANUAL. By Charles N. Pickworth. 112 pages, 5 x 7¼ inches. Published by D. Van Nostrand Co., 23 Murray Street, New York. Price $1.00.

This little book contains an unusually complete treatment of the use of the calculating slide rule. It opens with introductory chapters on the mathematical and mechanical principles of the slide rule, together with some historical reference to early slide rules. It then proceeds to give in a concise but thorough manner rules for the carrying out of all kinds of mathematical operations on the slide rule. A great number of examples are introduced in order to furnish practical application of the rules to the student.

MECHANICAL ENGINEERING AND MACHINE SHOP PRACTICE. By Stanley H. Moore. 502 pages, 6 x 9 inches. Published by the Hill Publishing Co., New York. Price $4.00.

This book deals with modern machine shop practice, and with the elements of mechanical engineering, and is designed in particular for the younger men in the shops. It contains a great variety of matter and is profusely illustrated. Some of the more important of the chapters are entitled Materials; Friction, Lubricants, and Lubrication; Cutting Tools; Measuring and Small Tools; Bench and Vise Work; Turning; Boring; Drilling; Grinding; Planing; Milling; Mechanics; Power Generating Machines; Elementary Electricity; Power Transmission; Motor Drives and Motor Driven Machine Tools. The index of the book is remarkably complete, and the information contained can therefore be easily located. Another feature of the work is also the classification by sections and numbered paragraphs, which tends to increase the value of the book for reference purposes.

HIGH SPEED DYNAMO ELECTRIC MACHINERY. By H. M. Hobart and A. G. Ellis. 526 pages, 6 x 9 inches. Published by John Wiley & Sons, New York. Price $6.00.

In the preface of this book the authors call attention to the fact that with the recent extensive introduction of high speeds in connection with steam and hydraulic turbines, the importance of thoroughly investigating the influence of such speeds on the design of dynamo electric machinery is quite obvious, and this has been the primary motive for the writing of the present treatise. The book is divided up in three parts, the first one dealing with general considerations, the second, with alternating current generators, and the third, with continuous current generators. The book contains an unusually large array of diagrams and definite data, as well as a very large number of explanatory illustrations, there being not less than 355 engravings. A carefully prepared index is provided, and should be of great value to the electrical engineer and to the student who wishes to go deeply and thoroughly into the subject of high speed electric machinery.

CATALOGUES AND CIRCULARS.

OLNEY & WARRIN, 66-68 Center St., New York. Pamphlet of the Olney & Warrin gas and gasoline engine.

PARK DROP FORGE CO., Cleveland, Ohio. Short Stories About Steel, No. 4, the subject being Benjamin Huntsman, Inventor of Crucible Steel, and The Heat Treatment of Steel.

CARSE BROTHERS CO., 165 Broadway, New York. Circular descriptive of the Reliance electrically driven swing saw for pattern shops and other woodworking shops.

LUCAS MACHINE TOOL CO., Cleveland, Ohio. Flyer entitled Pushing Things, presenting the Lucas power forcing press and the Lucas precision boring, drilling and milling machine.

TEMPLETON, KENLY & CO., LTD., Sloan St. and C. & N. W. Railway, Chicago, Ill. Catalogue descriptive of Simplex jacks for railways and industrial plants.

NEW YORK SCHOOL OF AUTOMOBILE ENGINEERS, 146 West 56th St., New York. Circular advertising the course of instruction offered in the care and operation of automobiles.

MONTGOMERY & CO., 105-107 Fulton St., New York. Catalogue No. 27, listing twist drills, mandrels, taper pins, dies, taps, reamers, belting, oil-stones, and a great variety of other tools and machines.

NORTON CO., Worcester, Mass. Booklet on Alundum, treating of its manufacturing peculiarities and qualities and value as an abrasive. The booklet is beautifully illustrated and interestingly written.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind. Bulletin No. 1107, Single Phase Switchboard Panels; No. 1108, Multi-phase Revolving-Field Belted Generator.

EXPANDED METAL AND CORRUGATED BAR CO., 925-937 Frisco Building, at St. Louis, Mo. Pamphlet entitled Designing Methods, Reinforced Concrete Construction, dealing particularly with bridges and culverts for highway traffic.

R. I. V. CO., 1771 Broadway, New York. Catalogue of radial ball bearings and ball thrust bearings for automobiles, line-shafts and other mechanical purposes. The company also sells imported steel balls in metric and English sizes guaranteed absolutely correct.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Booklet entitled Dixon's Ticonderoga Flake Graphite, treating of the qualities of flake graphite, and giving testimonials from users who have demonstrated its valuable lubricating qualities.

GISHOLT MACHINE CO., Madison, Wis. Leaflet illustrating 42-inch Gisholt vertical boring mill. This leaflet is punched for binding in a loose leaf binder supplied by the company to those who keep a file of its loose-leaf circulars.

WESTINGHOUSE TRACTION BRAKE CO., Pittsburg, Pa. Pamphlet entitled No. 12 EL Locomotive Brake Equipment, being instruction pamphlet No. T5037 issued by the company, for the information of persons interested in, and engaged in working with, electric locomotives.

NORTHWESTERN EXPANDED METAL CO., 930-950 Old Colony Building, Chicago, Ill. Pamphlet entitled Expanded Metal Information: Concrete and Steel, giving some interesting and valuable information regarding reinforced concrete construction.

LA SALLE MACHINE & TOOL CO., La Salle, Ill. Circular descriptive of No. 2 plain and surface grinder. This grinder is intended for general shop and tool-room use on all kinds of accurate surfacing. It sells for $50.

CLEVELAND TWIST DRILL CO., Cleveland, Ohio. Leaflet illustrating the new double tang sockets manufactured by the company to enable broken tang twist drills to be utilized by simply grinding a new tapered shank to fit the special sockets.

NATIONAL TUBE CO., Pittsburg, Pa. Advance sheets of book on the mechanical properties of Shelby seamless steel tubing prepared for the purpose of providing useful data for the users of seamless steel tubing in construction.

NORTHERN ENGINEERING WORKS, 26 Chene St., Detroit, Mich., has issued a little booklet on Northern cranes, containing 36 pages. In forty illustrations, many of the designs of electric traveling cranes, hand-power cranes, etc., manufactured by the company are shown.

ROCKFORD DRILLING MACHINE CO., Rockford, Ill. Catalogue of upright drills, gang drills, horizontal drilling, boring and tapping machines, tool-grinders, auxiliary drilling press. The catalogue is printed in colors and beautifully illustrated. It is a fine example of machine-tool advertising.

ZEH & HAHNEMANN CO., Newark, N. J. Pamphlet illustrating and describing standard power presses for punching, stamping and forming sheet metal work. The pamphlet illustrates inclinable, horn, punching, arch, double crank and armature disk notching presses; also double action presses, screw presses and drop hammers.

THE KEUFFEL & ESSER CO., 127 Fulton St., New York. Circular entitled New Goods, being a supplement to the regular price list of measuring tapes issued by the company. A number of different new measuring tapes with various types of holders and casings are illustrated.

EMERSON ELECTRIC MFG. CO., St. Louis, Mo. Bulletin No. 3306 descriptive of electric blowers for furnaces, driven by alternating or direct current motors. These blowers are for use in hot-air furnace heating systems to drive the hot air to rooms that do not heat well under ordinary conditions.

WILLIAM H. WOOD LOCO FIRE BOX AND TUBE PLATE CO., Media, Pa. Catalogue describing the Wood patent fire box and tube plates, showing a number of applications to locomotives on several prominent American railroads. Scully Steel and Iron Co., Chicago, Ill., acts as general sales agent for the Wood fire box and tube plate.

H. W. CALDWELL & SON CO., Western Ave., 17th-18th Sts., Chicago, Ill. Pamphlet descriptive of the machinery furnished by the company to the Hecker-Jones-Jewell mill, New York City. It illustrates and describes the rope drive, double disk clutches, barrel elevators, spiral lowering chutes, etc.

THE College of Engineering of the University of Illinois, Urbana, Ill., has issued a very handsome 36-page booklet, 5⅝ x 7⅝ inches, illustrating the work and equipment of the various departments. The half-tones are tinted, the subjects diversified, and there is the necessary descriptive matter accompanying each.

INDUSTRIAL OXYGEN CO., Hanover Bank building, New York. Booklet entitled The Weld that Held, with description of the autogenous welding process and the oxygenite process by which oxygen is produced on the spot required, by the combustion of special products in powder form. The pamphlet illustrates characteristic work that can be perfectly welded by the autogenous process.

NILES-BEMENT-POND CO., 111 Broadway, New York. Catalogue of Niles turning and boring mills, which are made in twelve sizes ranging from 30 inches to 20 feet swing; also extension boring and turning mills made in four sizes 10 feet-16 feet, to 16 feet-24 feet capacity. The catalogue contains 48 pages of text and illustrations, and is 9 x 12 inches.

SAWYER TOOL MFG. CO., Fitchburg, Mass. Catalogue of machinists tools, including scales, squares, depth gages, surface gages, hack-saws, thread gages, hammers, screw-drivers, center punches, etc. Among the new tools listed are a new surface gage for tool-makers, adjustable frame hack-saw, automatic two-stroke center punch, and new line of spring dividers and calipers.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4609 on Lamp Testing Watt Indicator; No. 4601 and No. 4602, Automatic Voltage Regulators for Alternating and Direct Current Generators; No. 4603, 220 Volts Direct Current Multiple Enclosed Arc Lamps; No. 4600, Controllers for Power and Mining Service; No. 4607, Incandescent System with Tungsten Lamps; No. 4610, Small Plant Continuous Current Switchboard Panels.

UNITED STATES ELECTRICAL TOOL CO., Cincinnati, Ohio. Catalogue E of U. S. electric hand and breast drills for drilling holes in wood and metal. A large variety of these tools is illustrated. Of special interest are the applications of the U. S. center grinders which convert an ordinary engine lathe into a grinding machine. The catalogue also illustrates the use of the portable electric grinder in a boring-mill, boring or grinding the doorway of an armor plate vault.

CARBORUNDUM CO., Niagara Falls, N. Y. Catalogue of carborundum products with explanatory description of the process of manufacture. This catalogue gives information on the characteristics of grinding wheels and the factors determining the selection of a wheel for given use. Sections of various shapes of formed wheels are illustrated, and the shapes of common wheels with dimensions are listed with prices. The book contains 125 pages, and is a superior example of catalogue work.

R. K. LE BLOND MACHINE TOOL CO., 4609 Eastern Ave., Cincinnati, Ohio. Catalogue descriptive of the LeBlond No. 1 universal cutter and tool grinder for which claims are made for rigidity, convenience, and simplicity. The catalogue gives directions for the operation, care, and use of the grinder, and diagrams for grinding clearance with plain wheel on straight and spiral mills. The application of the machine to grinding spiral milling cutters, double angle cutters, form milling cutters, cut-off saws, hand reamers, taper roughing reamers, circular forming tools, inserted tooth milling cutters, end mills, etc., illustrated.

GARDNER MACHINE CO., Beloit, Wis. Catalogue of Gardner improved disk grinders and disk grinder supplies. The No. 2 machine with two disks is illustrated with special tool-room equipment, regular tool-room equipment, standard equipment, special manufacturing equipment; also the No. 4 machine with tool-room and manufacturing equipment. Details of plain and universal swing tables, universal lever feed tables, and semi-universal feed tables are illustrated. The special No. 12 and 14 machines with various equipment are illustrated and described. The results are given of actual tests made with the Gardner improved disk grinders and grinding disks on piston rings, pump barrels, automobile parts, impellors for centrifugal pumps, centrifugal pump cases, babbitted boxes, wrenches, etc.

MANUFACTURERS NOTES.

HILL CLUTCH CO., Cleveland, Ohio, recently received an order from one of the subsidiary companies of the United States steel corporations for fifty-nine friction clutch pulleys.

PATTERSON, GOTTFRIED & HUNTER, LTD., New York City, have announced that the offices of the company have been removed from 146-150 Center Street to 211-215 Center Street and 147-151 Lafayette Street, New York City.

MESTA MACHINE CO., Pittsburg, Pa., has opened an office in Chicago at 844 Commercial National Bank building, from which point the company's business in rolling mill machinery, gas and steam engines, condensers, machine molded gears, and steel castings, will be taken care of by Mr. Lane Johnson.

STOEVER FOUNDRY & MFG. CO., Myerstown, Pa., announces that all sales of the company's product will in the future be handled from the New York office at 140 Cedar Street, New York City. Mr. Edward R. Euston, newly elected vice-president of the company, will act in the capacity of general sales manager.

S. OBERMAYER CO., Cincinnati, Ohio, has opened a branch warehouse in Erie, Pa., where a full line of foundry facings, core compounds, plumbago and blackings are carried at present. As soon as business conditions warrant, a complete line of other foundry supplies manufactured by the company will be carried in stock also. Mr. W. L. Scott is in charge of the new branch.